

HOW TO MAKE IT

Compiled from

Science and Invention

Edited by

H. WINFIELD SECOR

Managing Editor of Science and Invention

Details and Drawings showing how to build
home-made furniture, movie camera, telescopes,
radio cabinets, ice sleds, auto speedsters, oil
burners for furnace, drill presses, lathe, magnetic
treasure locator, telephones, full size boats,
chemical apparatus, et cetera.

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How To Make It

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INTRODUCTION



MAKING your own home furniture, telescopes, cameras, radio cabinets and hundreds of other handy little devices useful for the home laboratory, or for the household in general, is an entertaining as well as a money saving art. In the present book will be found hundreds of articles explaining how to make valuable things, some of which are not even available in the store. These articles have been selected carefully with the view in mind that everyone who buys the book will find something of interest to him therein. For instance, one will find in the present compilation full descriptive details on how to build your own drill press, lathe, oil burner for the house furnace of no matter what type, and many other useful articles which would cost a great deal of money, and possibly not work any better than a home-made device.

Those who like to build sport devices, such as motor speedsters or small racing cars designed to use a Ford engine or even a motorcycle engine, will find some very interesting and well illustrated descriptions in the present book. For winter sports there are to be found efficient ice boat speeders.

The average man is quite handy with tools even if he doesn't think so, and a good way to save considerable money is to build some of the furniture you may need for odd corners, for the porch, or even for the living room, and several clearly illustrated articles by Mr. Butterfield appear in the present book describing some attractive and unusual pieces of furniture.

The home mechanic will find it pays not to buy the cheapest tools, for a good steel tool will repay its owner many times over. The same thing holds true when it comes to painting and varnishing about the house, or in finishing up home-made furniture, etc. It never pays to buy cheap varnish unless the job is relatively unimportant, and this is especially true when it comes to floors. The home mechanic will find it pays him to provide himself with a set of good screw drivers of various sizes, together with a hack-saw, carpenter's cross-cut and rip saws, a carpenter's plane or two, a breast drill as well as a small hand drill, a set of files, including round, square and fine as well as cross-cut flat files, about twelve inches long; together with center punch, twist drills, and a good hammer. A few wood chisels always come in handy even to the average mechanic who doesn't dabble much in woodcraft.

It is well to remember in working with wood, and especially where gluing is to be done, that the best results are always obtained when the glue of practically any kind is heated, but it should not be boiled. In all cabinet factories, the glue pot is of the double boiler type where the outer pot contains water, the same as the well-known oatmeal cookers. Boiling the glue spoils its efficiency in most cases.

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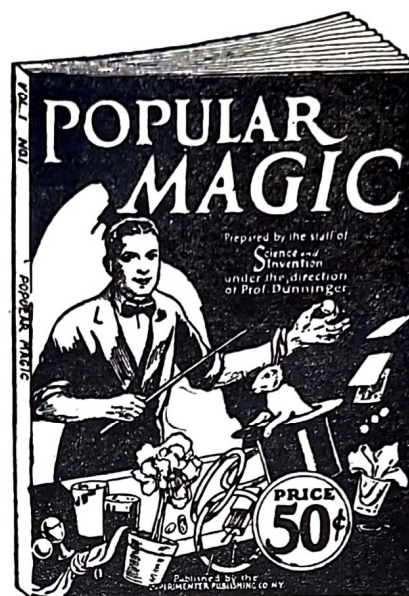
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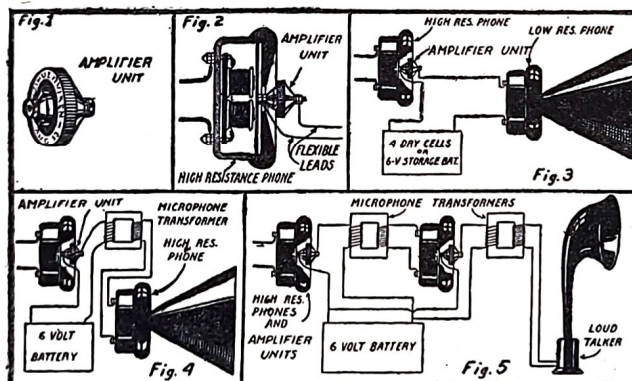


Fig. 1 shows the amplifier unit.

Fig. 2 shows how the unit is attached to a telephone receiver. The first procedure is to mount the unit on the diaphragm of a telephone receiver, which usually is a high resistance telephone, either 1,000 or 1,500 ohms.

Next we select the loud speaking telephone. If a low resistance telephone is available, it should have for maximum efficiency an impedance equal to the resistance of the amplifier unit, or about 10 ohms; it is connected up as shown in Figure 3. A 5 ohm telephone receiver is used in this circuit with a 6-volt storage battery.

Two telephones taken from a good double headset of 2,000 to 3,000 ohms which do not rattle on strong currents, are employed in Fig. 4, one at the receiving end, the other as loud talker. In

this hook-up there is one instrument which must absolutely be used with this combination, the transformer. As stated before in connection with Fig. 3, the impedance of the telephone, if used in direct connection, should equal the resistance of the unit. But as the impedance of the telephone in Fig. 4 is much higher than the resistance of the unit, it may be 200 times as great, a transformer having a step-up ratio is used to match up the resistance of the unit with the impedance of the loud speaking telephone. In other words, the primary coil of the transformer should have an impedance (which is sometimes called "A. C. resistance") equal to the resistance of the unit, or about 10 ohms, and the secondary coil should have an impedance equal to the impedance of the high resistance

telephone. This transformer may be purchased in any Radio Store and is called a microphone transformer or modulation transformer, designed primarily to use in radio transmitting sets. A 6-volt battery gives the best results. The current passing through the unit will vary from .1 to .25 ampere.

Fig. 5 shows a circuit for further increasing the volume of sound. This is simply two of the circuits, such as shown in Fig. 4, linked together. This arrangement is highly sensitive and the telephones on which the units are mounted should be packed in a box of cotton, as the slightest vibration or sound in the room will be picked up and heard in the loud talker. Any sensitive radio loud talker may be used in this particular circuit.

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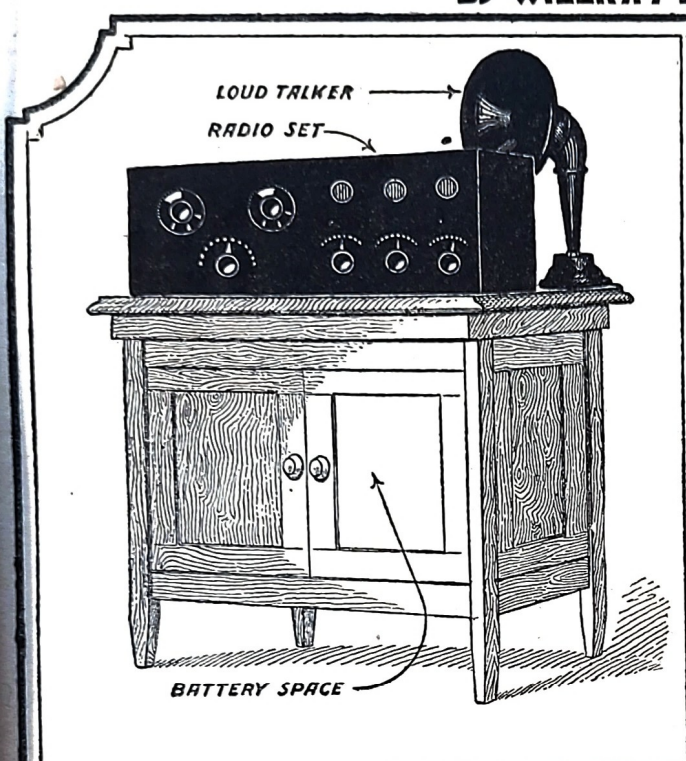
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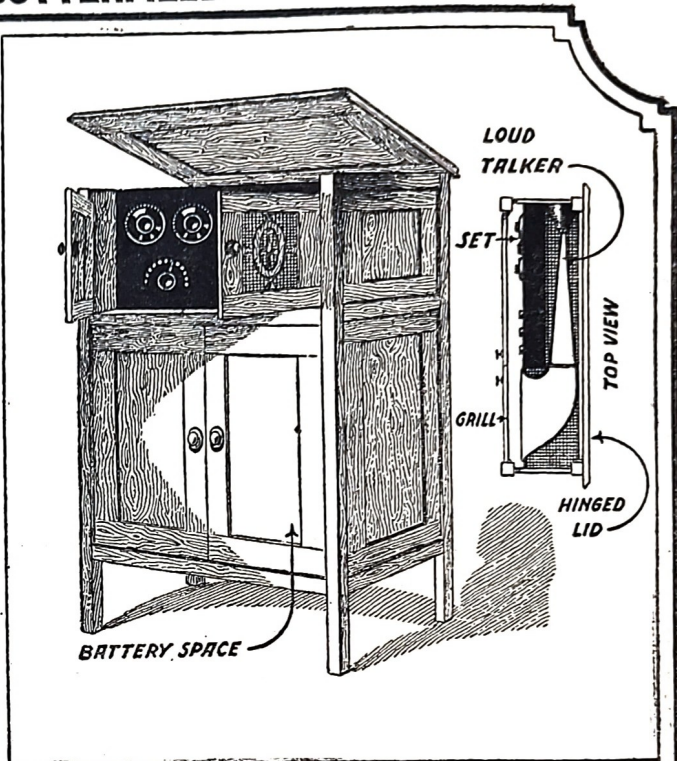
Styles of Radio Cabinets

Types of Construction That Prove Efficient

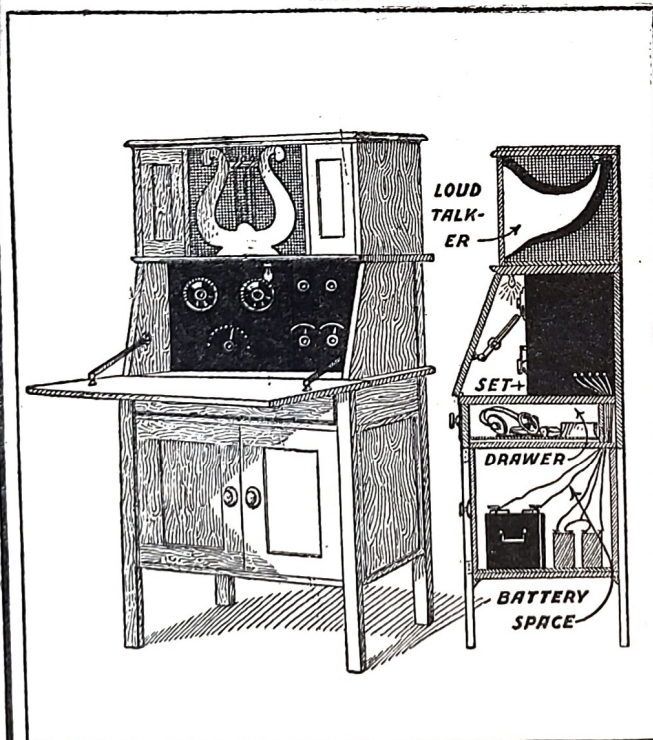
By WILLIAM BUTTERFIELD



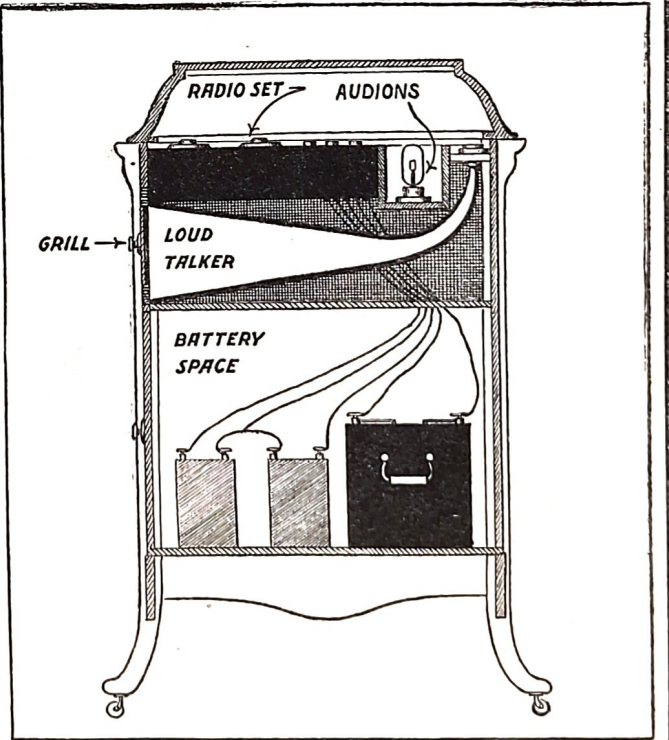
The simplest form of radio unit is the one shown above. It is a small cabinet upon which the radio set itself is placed, and in which the batteries, renewal parts and other accessories are kept. A cabinet of this type may take any one of a number of forms of construction so long as the cabinet is large enough to contain the necessary apparatus. Such a cabinet may often be found around the household.



A slightly more elaborate cabinet is one constructed in the design shown above. The loudspeaker is built in the top container together with the operating cabinet. The bottom portion is given over, as in the previous case, to housing the batteries and other necessary accessories to the operation of the set. With this type of construction all parts of the set may be reached with comparative ease in case of repairs.

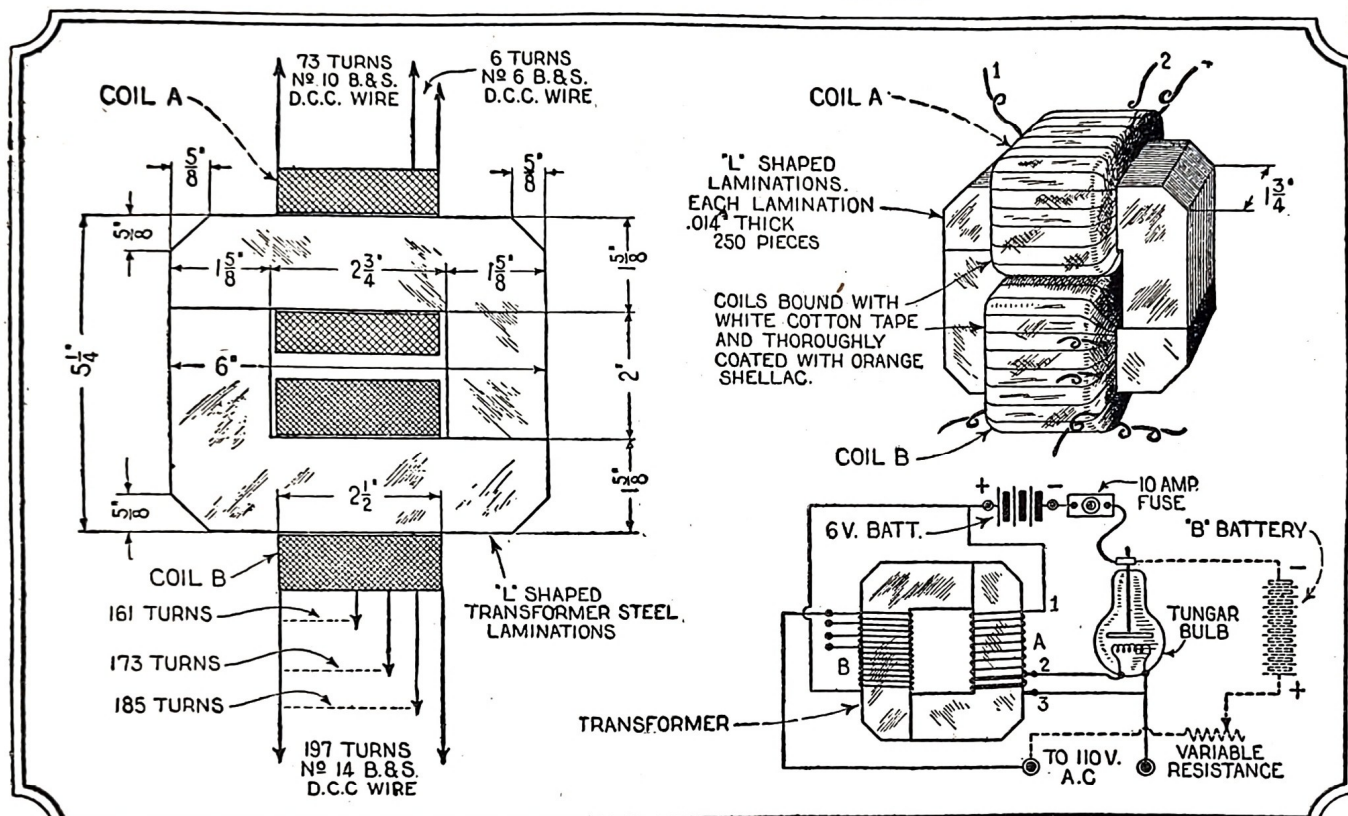


A still more elaborate case for a well confirmed "Radio Fan" is the one shown here. The cabinet takes the form of a writing desk and contains several refinements, which the arrangements previously shown do not contain. Note the small light above the operating cabinet, special drawer provided for head phones and bits of apparatus, and the ample space provided for a storage battery charger in the bottom compartment.



A radio set housed in a cabinet very similar to the well-known phonograph type is shown above. Some companies have commercially adopted this form and have met with no little success in selling them, tending to prove that this form of construction, aside from having exceptional acoustic properties, proves very handy to the operator. The construction is simple, and the necessary details of arrangement are shown in the sketch.

Tungar Charger



A transformer for the purpose of charging both the "A" and "B" batteries is detailed clearly above. It is well worth the trouble to construct. It is designed for operation on 110 volt, 60 cycle alternating current, and if carefully built will last indefinitely.

The time has come when the recharging of storage batteries, both "A" and "B" types, necessitates a much more convenient way than the carrying them several blocks to the nearest battery station, with, perhaps, the dire results accruing from spilling the acid over one's clothes. The best means of overcoming this difficulty is to charge them at home. A transformer for that purpose has been designed along the lines given in the above diagram and will meet all requirements. It is of the auto-transformer type, having three different windings on it. The core is made of laminated silicon steel, "L" shaped, in two sections, which are butted together and se-

curely fixed after the coils have been put in place.

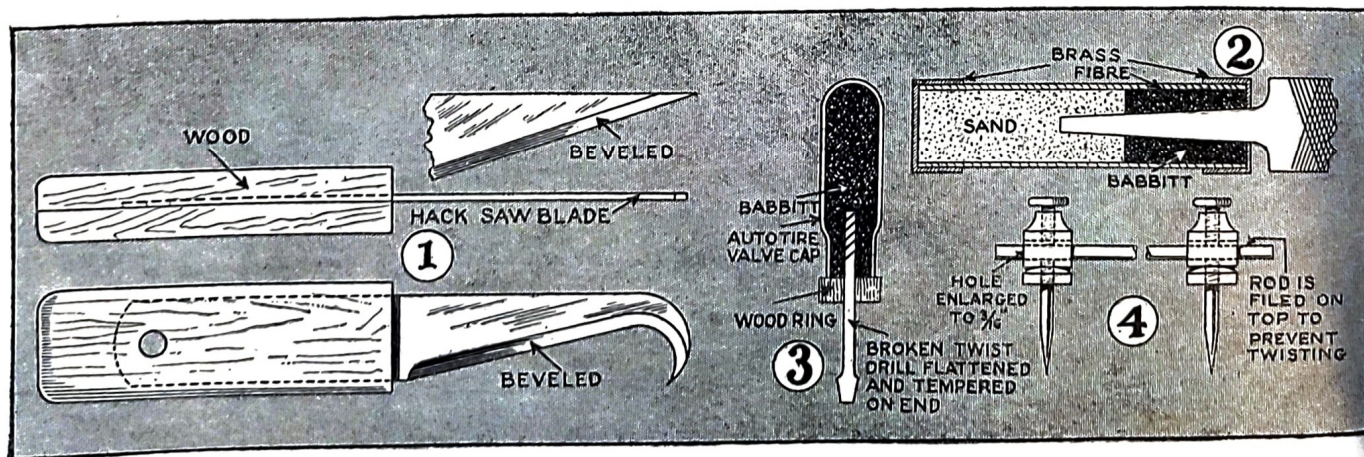
One hundred and twenty-five laminations are placed in a pile 1 3/4 inches high and constitute one leg of the core. Two or three layers of tape are wound tightly over it, after the laminations have been squeezed together as tightly as possible. On this are wound 197 turns of No. 14 B. & S. D.C.C. wire, taps being taken off at the 161st, 173rd and 185th turns. The winding must be confined within a space 2 1/2 inches wide. This is shown as coil "B" in the diagram.

After having prepared the second leg of the transformer as outlined above, six turns of No. 6 B. & S. D.C.C. wire are wound on

and serve as the filament winding. Directly over this are wound 73 turns of No. 10 B. & S. D.C.C. wire, which furnishes the current for charging the "A" battery. It will be noted that the two coils are connected in series with the winding on leg "B."

Having finished the windings, they are carefully taped and shellacked. The legs are then butted together and securely held together with wooden cleats. The variable resistance shown is a bank of five 40-watt lamps which is used to regulate the charging current. A 10-ampere fuse is connected in series with the battery and prevents overcharging. The transformer should be mounted on a slate or asbestos base.

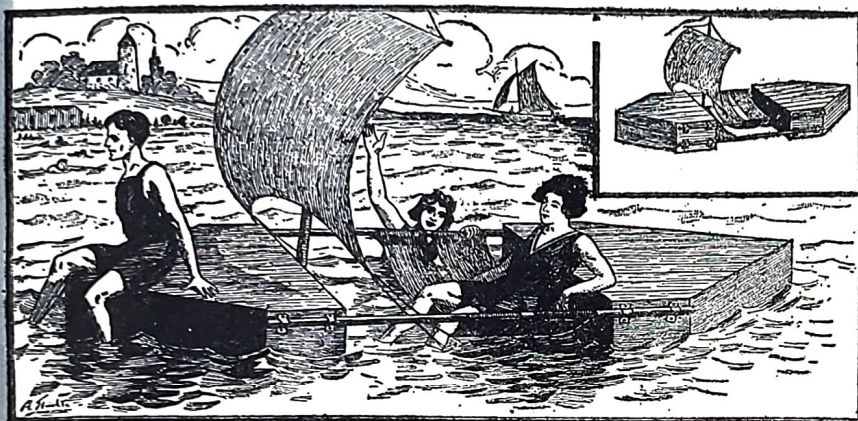
Uses for Broken Tools



A hack saw blade cut as at 1 and equipped with a handle makes an excellent tool for cutting tinoleum or roofing paper. An old fuse plug filled with sand and babbitt serves

well as a file handle, while a broken drill, a little babbitt and an auto tire valve cap make a screw driver. Binding posts are good trammel points, see Fig. 4.—T. B. Sage.

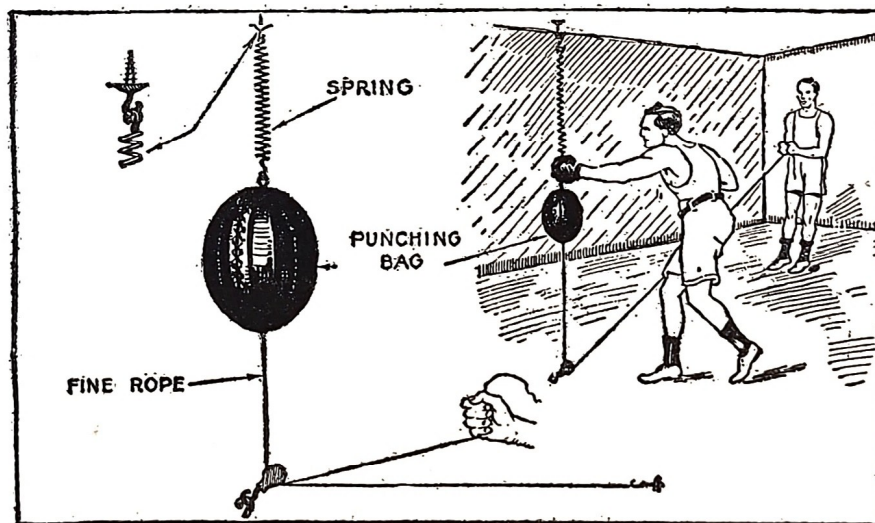
A Swimmer's Sail Boat



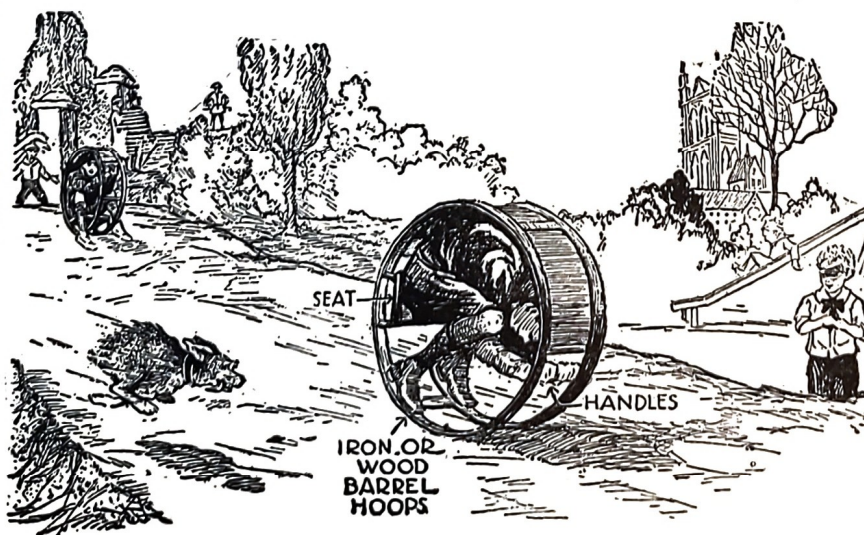
THE contrivance illustrated at the left will afford great pleasure to swimmers at resorts near large bodies of water. It is readily constructed from scrap material and consists of two wedge-shaped water-tight sections, one for the bow and one for the stern. These sections are connected together by means of four rods. The top and bottom of the sections should consist of boards $\frac{3}{8}$ -inch thick, while the sides should be made of 1-inch lumber. Assemble the sides and bottom and give the inside several coats of tar. Then nail the top on, calk all the joints and paint the outside with several coats of water-proof paint. If you want to be sure of having an unsinkable boat, fill the end sections with cork. Fasten the side rods in place as shown and provide a seat and sail. In lieu of a sail, an ordinary canoe paddle may be used to propel the boat.

The Dodging Bag

Very good practice for the amateur or even for the professional boxer may be had with the dodging bag illustrated at the right. This consists of an ordinary punching bag mounted in the rather unusual manner illustrated. A spring constitutes the top supporting member and the bottom rope, instead of being rigidly fastened as is the usual practice, passes through a pulley which in turn is fastened to the floor by a heavy screw eye. A second party holds the end of this rope in his hand as illustrated and as the boxer is practising, he pulls or releases this rope somewhat, causing the punching bag to go up or down. The boxer can thus develop quickness of eye and co-ordination between sight and muscles that cannot be obtained with the ordinary bag. —Gerald Enright.



Revolving Coaster

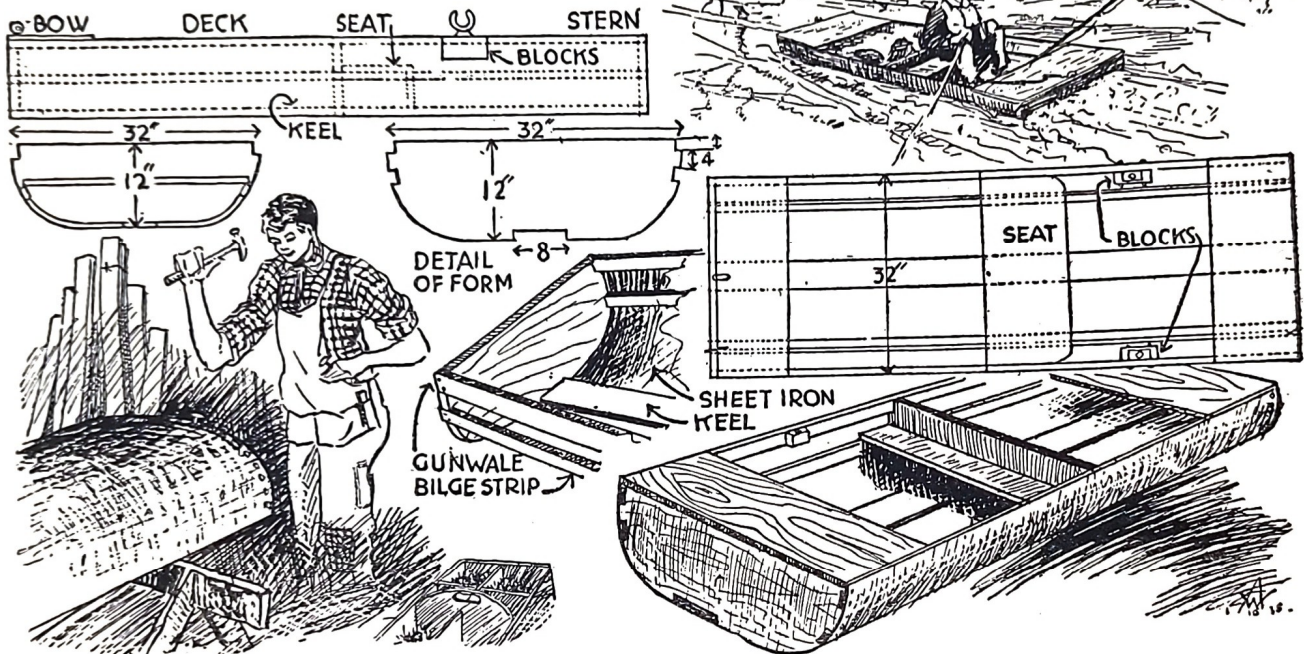


Great fun may be had by the youngsters with the revolving coaster illustrated at the left. The construction of the device is clearly shown. Two large hoops are used for the main framework and are connected together by means of cross strips. A handle is provided which is set back from the frame a few inches toward the center. Thus the operator's hands are protected from the ground. Almost opposite the handle, a seat is fastened as shown. Part of the framework may be covered with canvas or a very thin strip of wood curved to the shape required. In starting, the user assumes his position at the top of a slight grade as shown at the extreme left. Then with a slight push of his feet and at the same time drawing them in, and resting them on the hoops, he rolls down the embankment at an exhilarating speed.

Sheet Metal Fishing Punt

By L. B. ROBBINS

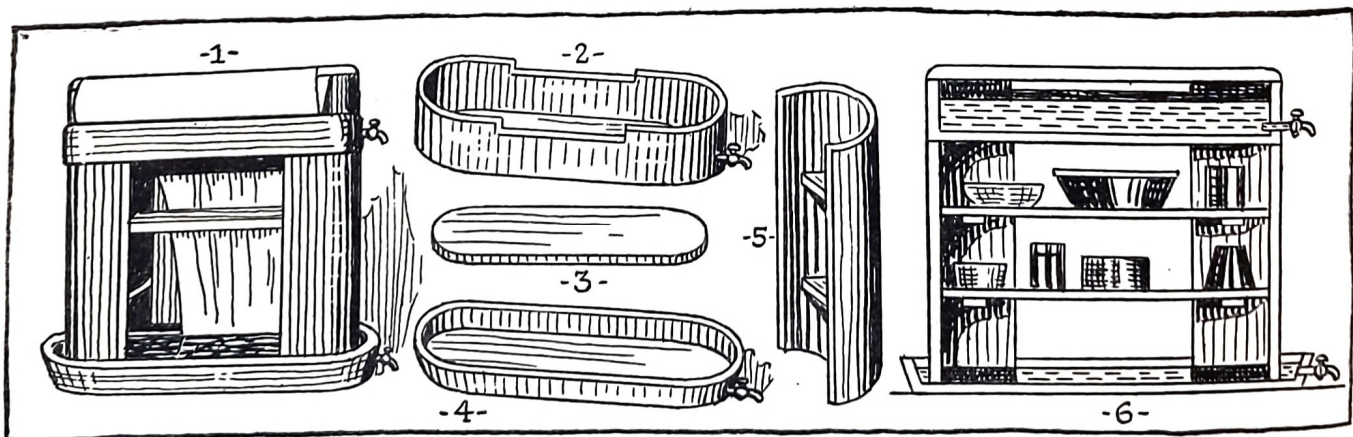
We give herewith the constructional details of a serviceable river punt that can be built of a few pieces of board and some galvanized sheet iron. It will carry two passengers comfortably and calls for no skill in carpentry in its construction.



In the construction of this boat, first cut three forms from one inch cypress for the end and center blocks. Place two about ten feet apart with the third in the center, and fasten the keel in place with wood screws. Then fasten the gunwale and bilge strips as shown, taking care that the surfaces of all the strips come flush with the edges of the forms. The outside covering of this boat consists of a single sheet of light gauge galvanized iron ten feet long and somewhat over four

feet wide. Coat the edges of the form with white lead and lay a one and one-half inch wide strip of flannel soaked in white lead over the edges to prevent leakage. With an assistant, lay the sheet iron over the frame and fasten in place with $1\frac{1}{2}$ -inch galvanized screws, placing them 2 inches apart. Bend the iron over the gunwale strips and fasten with wire nails. Deck over each end of the boat and insert a seat as shown. Oarlocks and a thorough coat of paint complete the boat.

An Iceless Refrigerator



For use in warm climates and during the summer months in temperate zones, the iceless refrigerator illustrated above is handy and economical. 1 shows the completed assembly with the strip of cloth rolled up. 2, 3, 4 and 5 show the concrete castings to be made. Two ends such as illustrated at 5 are necessary. These parts are assembled as shown

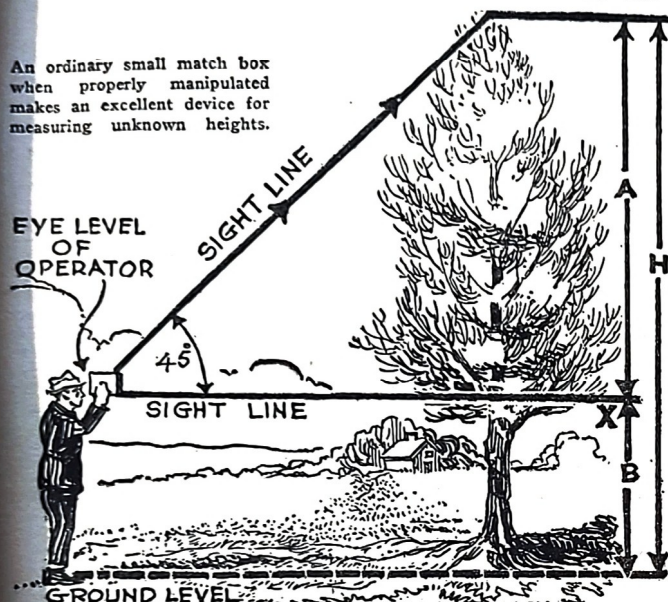
in 1 and 6. A cloth is laid over the top tank, its ends dipping in the water in the lower tank. Evaporation keeps any materials placed on the wooden shelves cool and also cools the water in the upper tank which may be used for drinking purposes. Two faucets should be molded directly in the concrete block.

—Ruth D. Shultis.

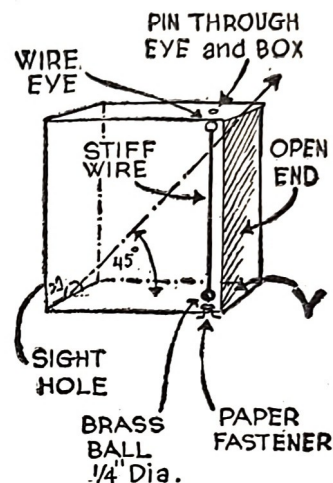
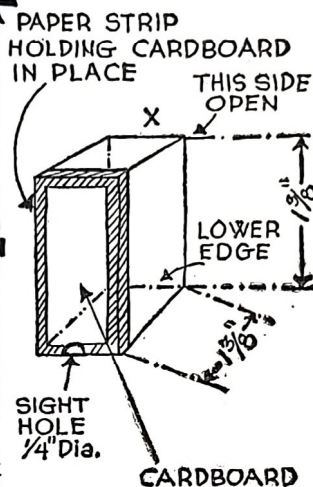
Measuring Heights with Match Box

By C. A. OLDROYD

An ordinary small match box when properly manipulated makes an excellent device for measuring unknown heights.

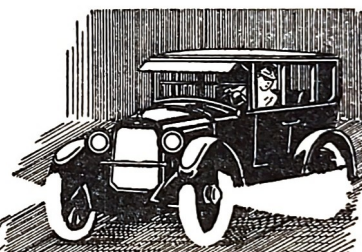
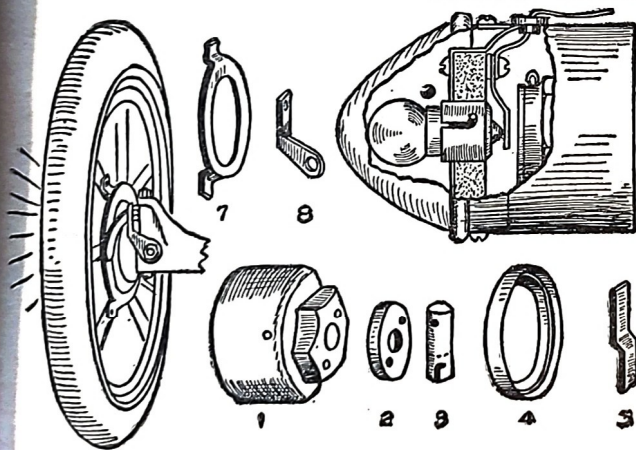


The match box, the dimensions of which are known, is held in the hands as shown above and sights taken along the two lines indicated.



The match box used should preferably be cut to the sizes shown above, with the small hole. When the operator has moved so that the sight lines indicated are obtained, the height of the object is equal to the distance of the operator from the object plus the height of the operator's eye from the ground, or in the illustration at the left, H is equal to the distance from the tree to the operator, plus the distance B . A pendulum as shown above insures the box being level.

Auto Hub Cap Lights



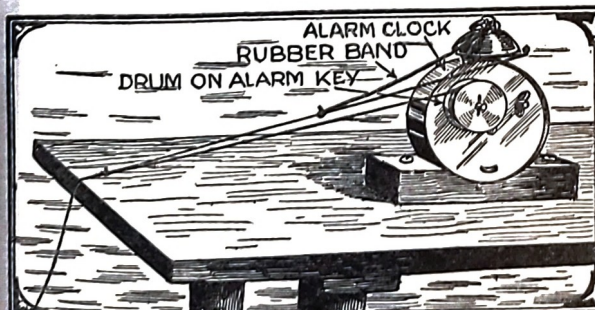
- 1-FORD HUB CAP
- 2-FIBRE RING
- 3-FORD HEADLIGHT SOCKET
- 4-BRASS RING
- 5-CONTACT PLATE
- 6-LAMP GLOBE
- 7-CONTACT RING
- 8-BRACKET FOR CONTACT BRUSH
- 9-CONTACT BRUSH
- 10-FIBRE WASHER
- 11-BRASS WASHER
- 12-BOLT

Lights on the front hub caps of automobiles make an interesting and distinctive novelty. They may be made as shown above. They may be controlled separately or together, as desired, by means of switches. A hole is drilled in the center of the hub cap to hold the socket and fiber ring. As the socket is soldered to the hub cap, it forms a ground return,

necessitating the use of only one wire. The latter is connected to a contact ring (7) to which contact is made by means of a brush. The electric light bulb is protected by means of a bullet shaped globe obtainable from any accessory dealer. This globe must be of quite thick glass although it is not supposed to hit anything.

—L. O. Van Riper.

Automatic Fisherman

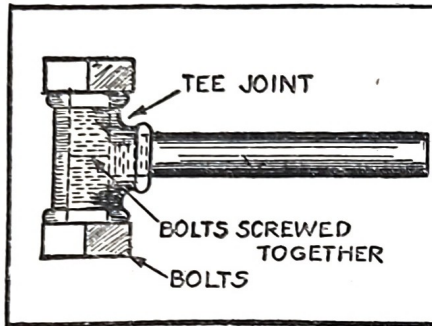


An alarm clock securely fastened to a base makes an automatic fisherman that will "play" a fish until the owner desires to pull it in. The clock is set to ring, but the stop is set so that it cannot do so. A small drum is placed on the alarm key and the fish line fastened to it. A second string

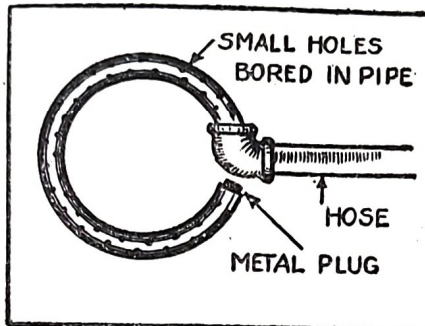
is knotted to the line and fastened to the alarm release. A rubber band helps to take up the shock when the fish bites. A fish pulling on the line releases the alarm and the spring "plays" the fish. Some fishermen would prefer to do the playing themselves.

—Jacob Schmidt.

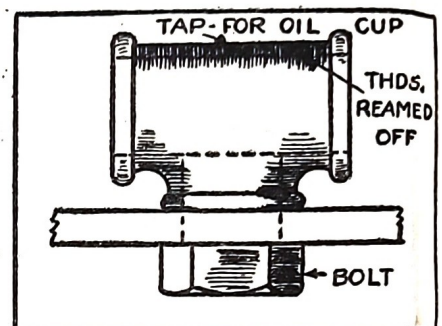
Uses for Odd Pipe Scraps



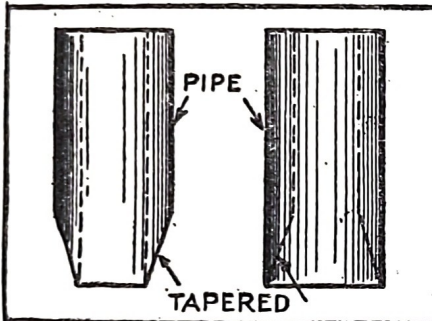
A tee joint with a short length of pipe for a handle can be made into a very serviceable mallet by screwing two bolts into the inside of the tee.



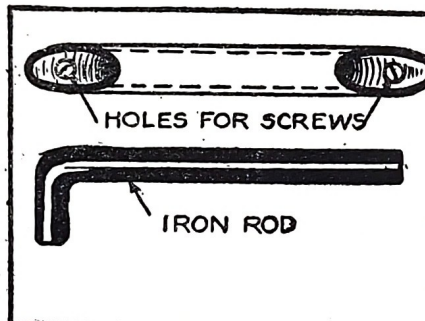
The summer lawn can be watered very easily with the aid of a small piece of pipe bent into something near a curve and drilled as shown above.



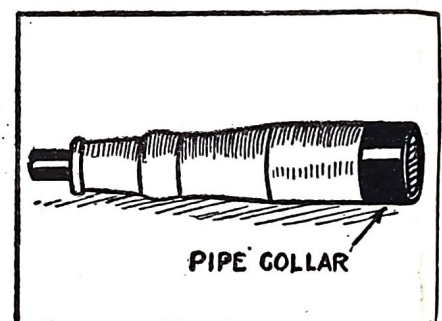
For a shaft hanger a malleable iron tee joint with its threads reamed out will serve very well in an emergency. A bolt in the bottom supports the bearing.



A whole set of punches and dies can be made by drilling and sharpening pipes of different sizes, as shown in the above illustration.

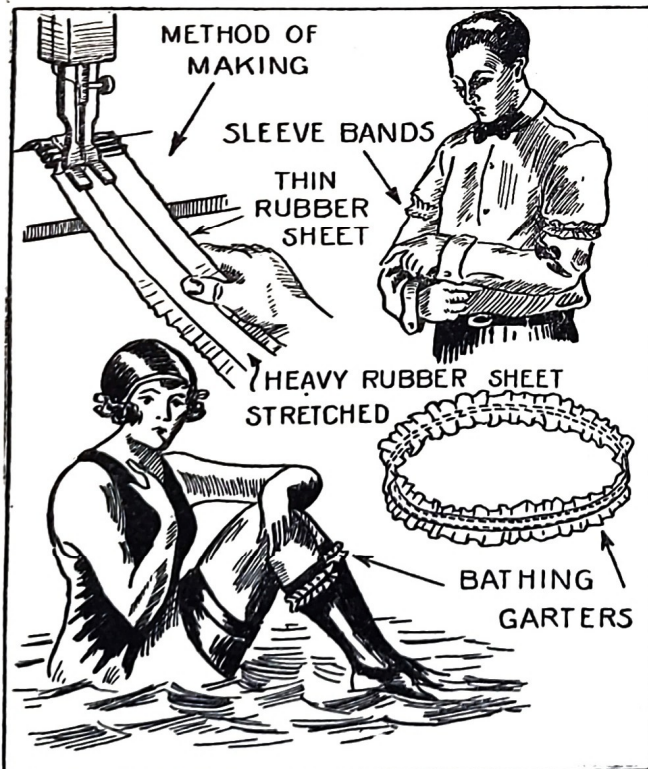


The door bolt is one of the simplest and most useful devices which can be made with the aid of pipe scraps. Such a bolt is shown above.



Split tool-handle can be quickly and efficiently repaired by placing a pipe collar over the top of the handle to strengthen it.—J. G. Morris.

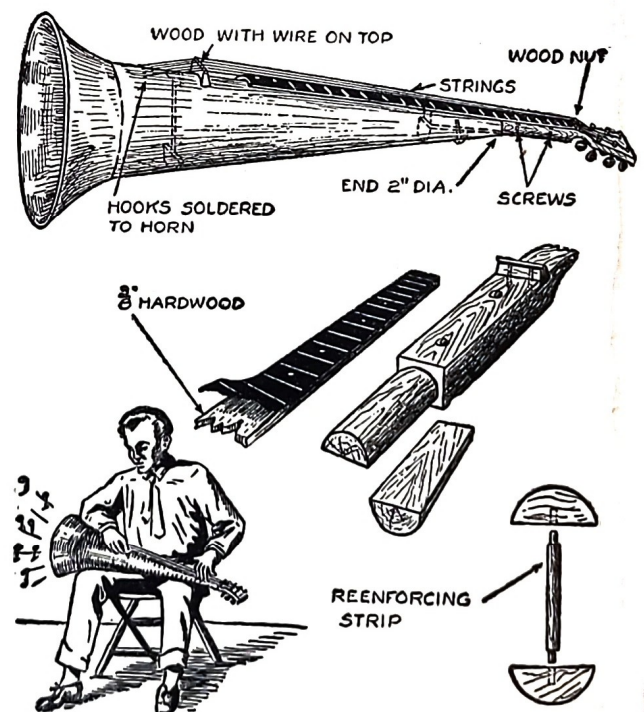
Bathing Garters



Many times the summer bather is incommode for lack of a serviceable garter which will withstand both ordinary wear and tear as well as constant subjection to salt water effects. The commercial article when used in water deteriorates and falls apart after one or two uses. The above article, however, made by simply gathering on a sewing machine a solid rubber band of the proper weight, is entirely free from this trouble since rubber is a solid sheet and not a series of small bands.

—Stefan Prospect.

Musical Instrument

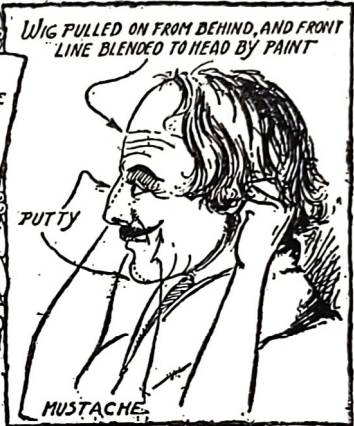


An extremely mellow musical instrument, an adaptation of the Hawaiian guitar, can be made by the handy craftsman from an old horn, some strings, a little hardwood and a few violin pegs. The top of the horn is cut off, and the neck inserted, as shown. It is wedged into the horn securely by the use of a rounded wooden piece which fits under the neck. A finger board is purchased and pasted on a hardwood finger board, which runs down the top of the horn. The construction of the bridge is clear. The nut which holds the strings above the finger board next the head is also of hardwood and fits in a groove. The strings are stretched by violin pegs. The construction of the sounding post, reinforced, is clearly shown at the right.

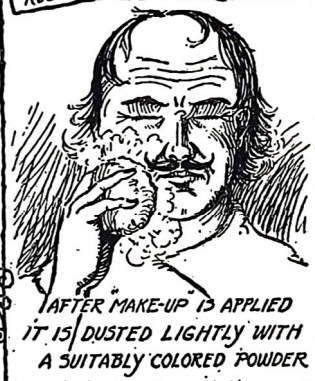
—J. H. Muldoon.

How Amateur Actors Make-Up

By L. B. ROBBINS



In the figure above the actor is ready to put on his make-up. To the right he is seen with the daubs of ground color spread out over his face. The next figure to the right illustrates how the distinguishing facial expressions are applied. The wig is then pulled down over the head after the nose has been built up with putty, and the mustache applied. As illustrated below, the semblance of missing teeth can be produced by using black wax which is molded over the teeth.

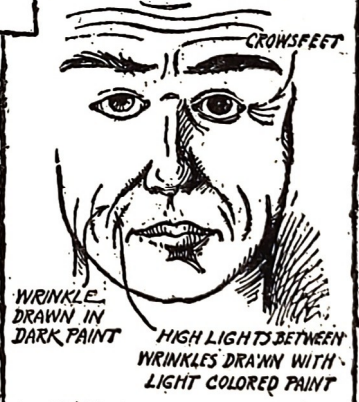


The two illustrations to the left indicate the final touches in the amateur make-up. To heighten the eyes and enlarge them, the eyebrows are darkened with paint and the lashes touched up. Then a dark line is drawn above and below the edges of the lids to meet at the outer corner of the eye. Features may be altered with nose putty as illustrated on this page, and a plump hand is made to appear aged and scrawny, by giving them a neutral shade and then coloring as illustrated below left.

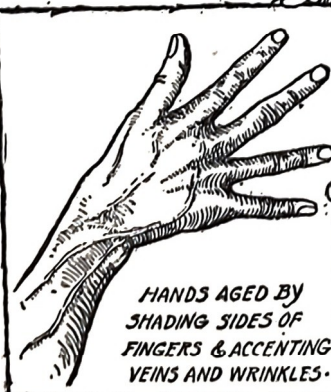


The use of tooth wax is shown above.

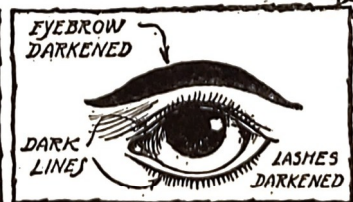
MANY amateur theatricals fall flat in one essential, namely that of stage make-up. When one considers the art as a whole, he will find that making up for the play is very simple. In order to simplify the process still more, the illustrations on this page are made in such a way that each process is clearly brought forth. The colors and paints are scientifically prepared and are available in handy containers ready for instant use. All that the actor really has to do is to visualize the character in his mind and then prepare his own features with color and line to form that character. The process in general is as follows: The actor seats himself before a well lighted mirror with the powders and grease paints spread out in front of him on the table. A towel or cloth is wrapped around the neck for protection, and then cocoa butter or cold cream is rubbed thinly into the skin to fill the pores and prepare a suitable surface to work on. Making wrinkles successfully is an art in itself. They are first drawn in the required place with a sharp lining stick, then just above each line or between two adjacent ones, a line of lighter color than the flesh is filled in. This is the high light; the dark line is shadow. These two lines are then softly blended with the finger to tone them down. The other features of the make-up are shown on this page.



Above one sees the method of producing wrinkles.



How a plump hand looks when aged.



The natural eye and the effect upon it when properly made up, is here illustrated.

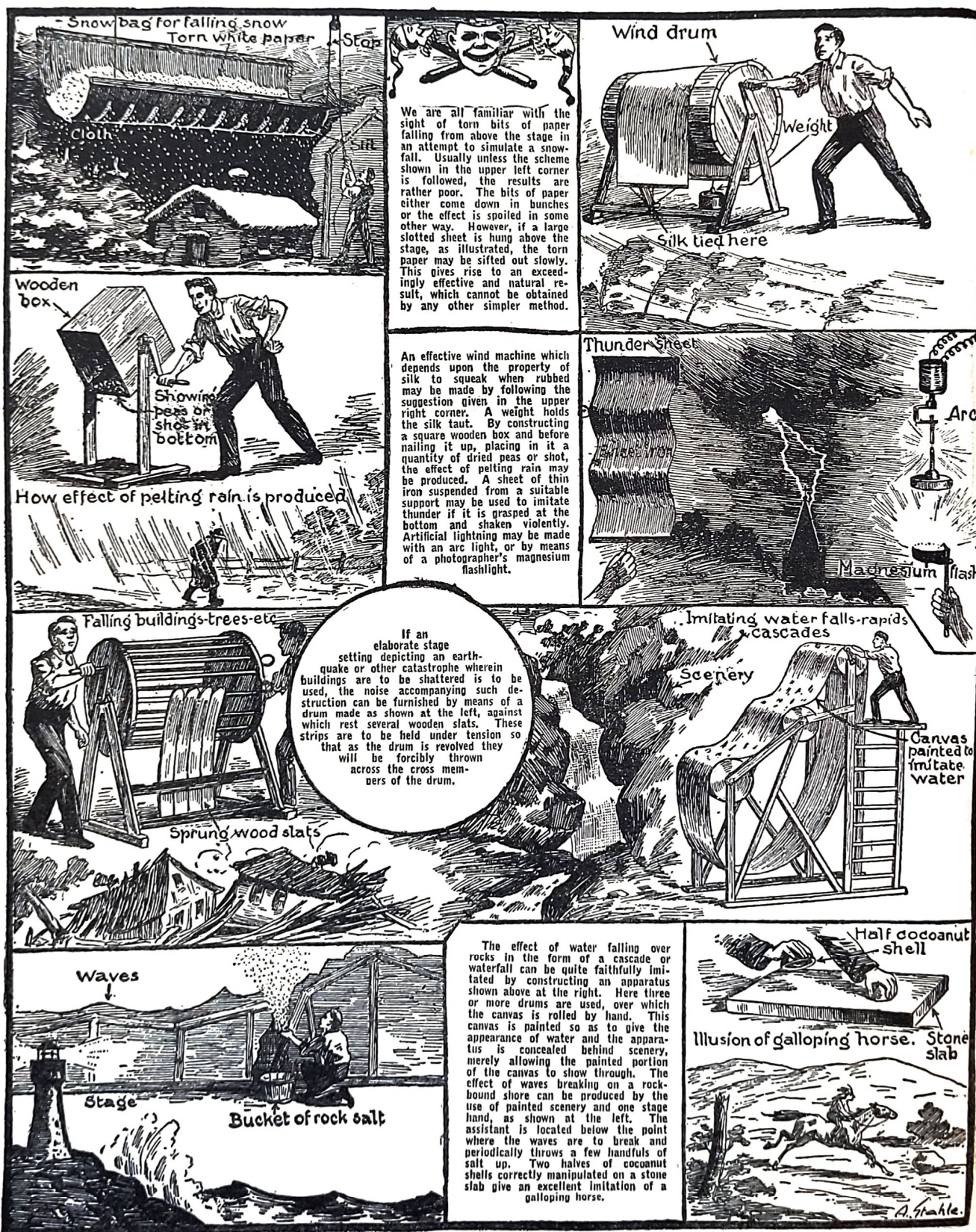


How nose putty can alter the features.

Nature Effects in the Theatre

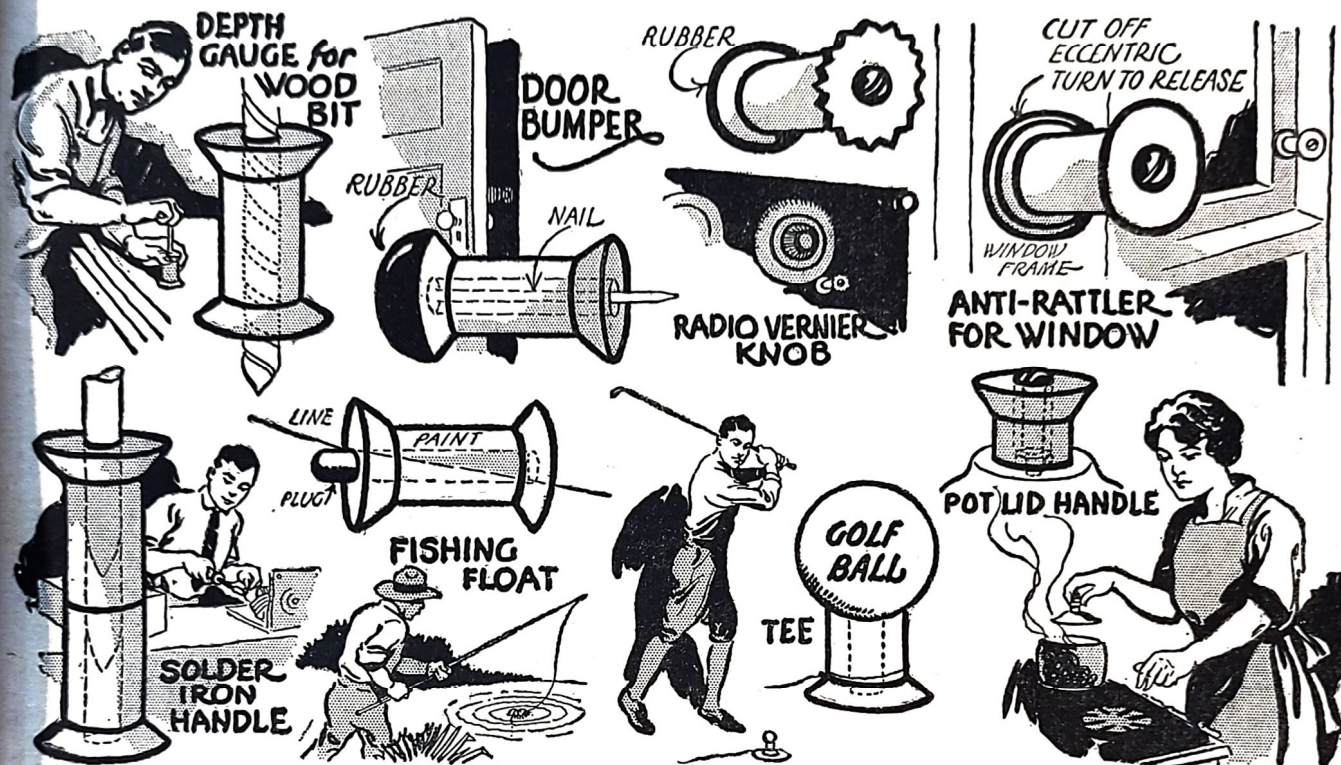
Suggestions of Use to Amateur Theatricals

By L. B. ROBBINS



Uses for Old Spools

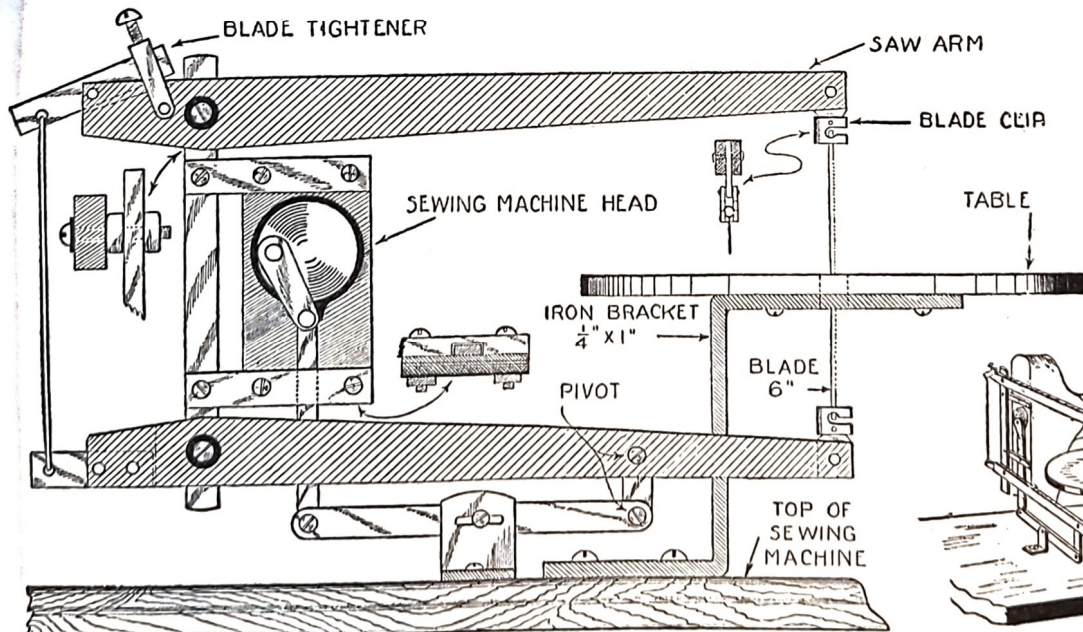
By WALTER MARKOWSKI



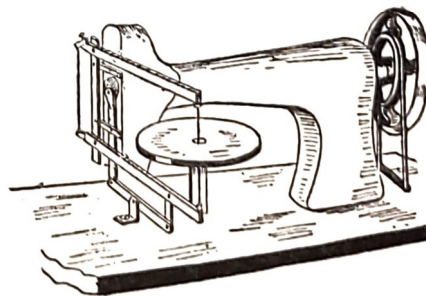
Old spools can be put to so many uses that one really wonders why they are thrown away. These suggestions shown in the illustration above do not complete the number of purposes to which empty spools admirably lend themselves. The enterprising reader will find no difficulty in discovering other useful applications. In the anti-window-rattler shown one side

of the spool is cut off eccentrically and then the spool is mounted near the window frame. By turning it, a wedge-like fit is produced between window sash and frame so that it will not rattle. As the fishing float the line is passed through the center of a spool and held in place by a wooden plug.

Scroll Saw from Sewing Machine



A few pieces of scrap iron and strips of hard wood will enable anyone to build a handy and serviceable foot-power scroll saw, if they follow the drawings given herewith.



The plate covering the left end of the sewing machine arm is removed, exposing the crank stud to which the short arm shown is attached. The reciprocating motion thus obtained is transferred through the various arms to the saw blade. The latter is of the 6-inch-long type and can be obtained at any hardware store. Tension is applied to the blade by

means of the adjusting screw shown. The table may be a disk of wood or steel, according to which is easiest to obtain. The iron bracket supporting it must be rigid in order to insure the production of good work on the finished machine.

—Harold Jackson, Rep. No. 2903.

Building a Double Neck Harp-Guitar

By C. L. EDWARDS

THE following description explains the correct way to assemble the parts of the Harp-Guitar shown in the drawings and, in addition, describes the general process of Musical Instrument Building so that any Regular Guitar, Lyre-Guitar, Bass Guitar, Mandolin, Zither, Lute, Ukulele, Autoharp, Celestaphone, or Guitar-Mandolin, can be easily assembled, as the methods of bending wood, gluing, clamping, purfling, inlaying, etc., are practically the same, and the various clamps, forms, etc., can be easily designed for each instrument.

In general tops or sounding boards are made of spruce or clear Northern pine.

Sides, backs, necks, fingerboards, etc., are generally made of rosewood, cherry, mahogany, walnut, birch, maple or similar woods.

Fingerboards are generally dark to show frets and position marks better.

Bridges, frets and string nuts can be made of metal, bone, hard wood, ivory, etc.

Always use first quality, well seasoned stock.

Hard wood string nuts and bridge and metal frets are recommended for the harp-guitar.

Cross braces and blocks are made of hard or soft wood to suit the instrument according to the strain they have to withstand.

Celluloid, ivory, pearl, metals and fancy woods are used for ornamental work.

All these supplies can be obtained from wood mills doing cabinet work.

Gluing Directions

Never use fish glue or any kind of prepared glue, always use the best cabinet makers' glue freshly prepared. Keep the glue pot clean. Try test pieces, No. 21, often. Do all your gluing in a place that is both warm and dry; never glue cold or moist pieces. When heating wood pieces have the heat strike equally on all sides to prevent warping. Don't try to work upon a piece while glue is drying.

When gluing two parts together, put the glue on the cooler part, but have both warm. Slightly roughen the surfaces to be glued. Fill the pores of end grains with thin glue; let this dry, and scrape smooth before applying the regular glue. Clean off the surplus glue and any that oozes from between the joints at once with a damp cloth or scrape smooth when dry.

Assembling Directions

Top No. 1 and back No. 5 are shown only a little past the center line. The other side, not shown, is precisely the same.

Have flat boards about $\frac{1}{4}$ inch thick with one straight edge. Lay drawings of top No. 1 on one of the boards with center line on the straight edge. Cut the board to outline of top No. 1. Do not cut out sound hole. Make four of these. They are to be called "Patterns."

Using the first pattern lay out body from No. 17, the pattern forms the inside line of the body form. This work had better be done on a band saw to keep sides square.

It is best to make the body form of several thin boards laid with the grains crossing and glued together.

The top No. 1, back No. 5 and sides No. 14 can be made 3-16 inch thick.

Staining, if needed, should be done, wherever possible after the final smoothing of the wood. If the grain of the wood rises, smooth down again.

When clamping or holding work always use pads of some kind to prevent bruising it. To prevent drying glue from sticking to whatever it is resting upon, put paper between work and the gripping device or table and scrape the paper off when the glue is dry.

Make two sides No. 14, the head block No. 6; the latter to be $4\frac{1}{2}$ inches deep and of tough hard wood; make tail block No. 7, $5\frac{1}{4}$ inches deep and of hard wood; make cross braces C, D, E, F, G on top No. 1 and H, I, J, K, and center strip No. 9 on back No. 5, also of maple or other hard wood. Cross braces C, D, E, G, I are $\frac{1}{2}$ oval in cross section, gradually thickening towards center, tapering suddenly to knife edge at ends. Braces F, H, J, K and center strip No. 9 are flat and of the same thickness along their entire length.

Center strip No. 9 is not used where back No. 5 can be made in one piece.

Make about 40 clamps like No. 16; then procure about 80 spring clothes pins, and a piece of iron pipe with thick sides about 4 inch-6 inch diameter and 12 inch long. Have outside of pipe clean.

Make bending blocks No. 18 and cross brace of any wood.

Make two string nuts No. 12 and bridge No. 3 of very hard wood and then right and left necks No. 10 including heels; make finger boards No. 11 without frets and plates No. 13; make plates and finger boards a little longer and wider than shown.

Make top No. 1 of one piece if possible, otherwise of two pieces glued in center. Let the edges extend $\frac{1}{4}$ inch beyond drawing. Glue cross braces in place, using weights or other means to hold the braces in place while drying.

Make back No. 5 in a similar way, let edges project $\frac{1}{4}$ inch, only do not glue cross braces in place until the back has been heated to a very high temperature so that it is hot clear thru and very dry, then still keeping it at this temperature, glue cross braces in position, keeping it at the same temperature until glue is dry. A small room heated excessively is a good place for this. When cross braces are fast, remove from the heat. Moisture will re-enter the wood and swell it sideways; it cannot swell on the side upon which the cross braces are located, but will do so on the other side, thus curving the whole back, and giving it a better appearance and tone. Now glue No. 9 between braces.

The back can be bowed also by making the cross braces thicker, cutting them to required curve and gluing them to the back. This makes a heavier construction, but obviates the excessive heating required in the other method.

Screw body form No. 17 together, leaving about a $\frac{1}{8}$ " gap at each end. Now measure the inside of the body form from end to end by a thin flexible strip or shim. Cut sides No. 14 to this length.

Heat the piece of iron pipe until it will almost scorch thin soft wood. Moisten the piece that is to be the inside of one side No. 14, roll the moistened part on the hot pipe until it is flexible, then put in place in the body form, it must touch the body form along its full length, use clamps if necessary.

Treat the other No. 14 in the same way, put bending blocks No. 18 and cross brace in position and screw ends of body form together until ends of sides No. 14 butt together tightly.

Glue head block No. 6 and tail block No. 7 in place, let them project beyond sides at each edge, glue gluing strips No. 8 in place, holding with spring clothes pins, then carefully level tops of gluing strips and sides, lay top No. 1 and back No. 5 in place, if cross braces touch gluing strips, trim braces off.

Take pieces of strong closely woven tape about $\frac{1}{2}$ inch or $\frac{3}{8}$ inch wide and glue across sides and over gluing strips. Place about 3 inches apart. These are No. 22.

Lay the back No. 5 in position, mark where inside of gluing strips comes. Varnish or shellac inside of back, but do not put any

glue on the place where the back glues to the gluing strips or sides.

Glue top No. 1 in position by putting two patterns over the top and two on the opposite side to prevent bruising wood of top and sides. Fasten with clamps No. 16, then varnish or shellac the sides and top on the inside, first removing bending blocks and replacing with a stick, remove all loose pieces from sides or top, replace bending blocks, and fasten back in same way, or the process can be reversed and top put on last.

Take out bending blocks and cross brace thru sound hole, trim projecting edges of top and back, cutting dove-tails for necks so that the necks are flush with the top No. 1 and 5 inches apart, center to center at ends.

Take the fret scale No. 15, if it is longer than dimension, put in a hot, dry place until it shrinks, if too short, put in a moist place, when right, put on finger board with end touching front of string nut. The 12th fret should be over where the center line of necks meets body line; the body is the assembled top, sides, and back. Carefully mark positions; make saw cuts narrower than frets; hit bottom of frets on edges with corner of chisel to make little projections that will grip the wood, then hammer them into saw cuts with some soft material, do not drive in from the end.

Another way is to make saw cuts wider than frets and fasten with shellac.

Make some kind of a head-brace; now glue the neck to the body and the projecting end of finger boards to top by taking any kind of a clamp that will reach one arm thru the sound hole and press against the under side of top, the other arm pressing down on the finger board to hold it tightly against the top; put head brace in at this time. This should be mortised and glued to necks.

A filler strip of some ornamental material is fitted and an end peg put in place.

Glue bridge No. 3 in place so that if the center lines of the necks were permitted to cross the bridge, the distance would be nearly $12\frac{1}{8}$ " from the center of 12th fret to front of bridge.

Put wood screws where the ornaments at each end of the bridge are to be, to hold bridge while glue is drying, then take screws out.

Position marks are shown in one neck, these are made slightly larger than a wood bit of required diameter and the sides are sloped at a uniform taper all around.

Bore a little ways into the wood with the wood bit, then force ornaments in place, using shellac to bind metal ornaments to the wood. Glue is used to fasten wood and a mixture of two parts shellac in two parts spirits of camphor and 6 to 8 parts of 90% alcohol to fasten celluloid to wood. There are many prepared mixtures suitable.

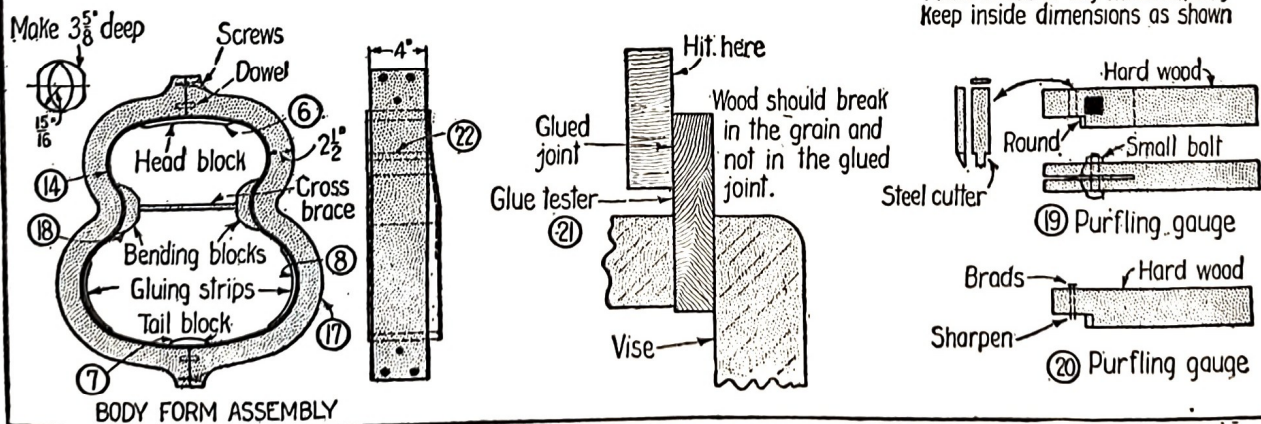
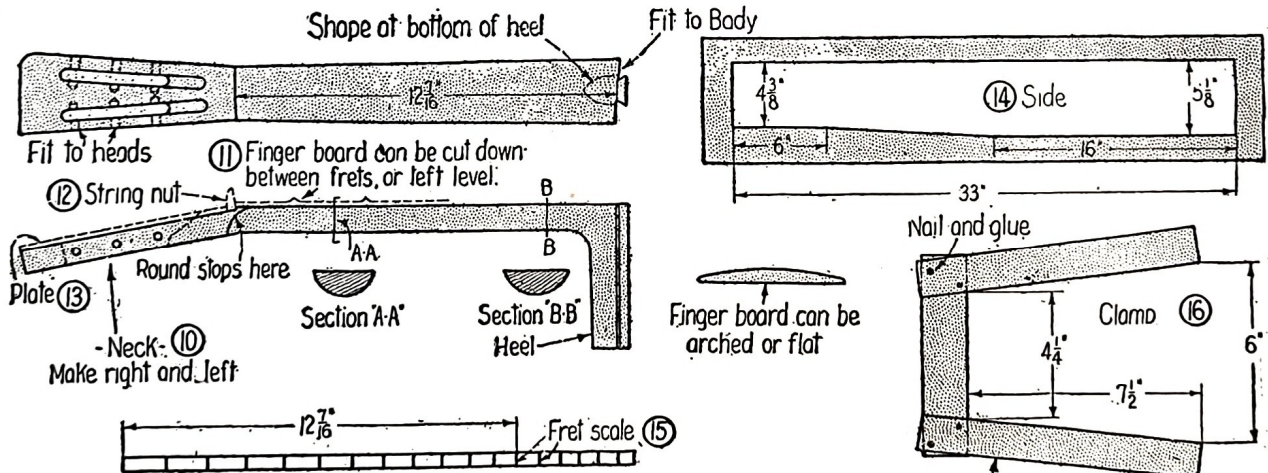
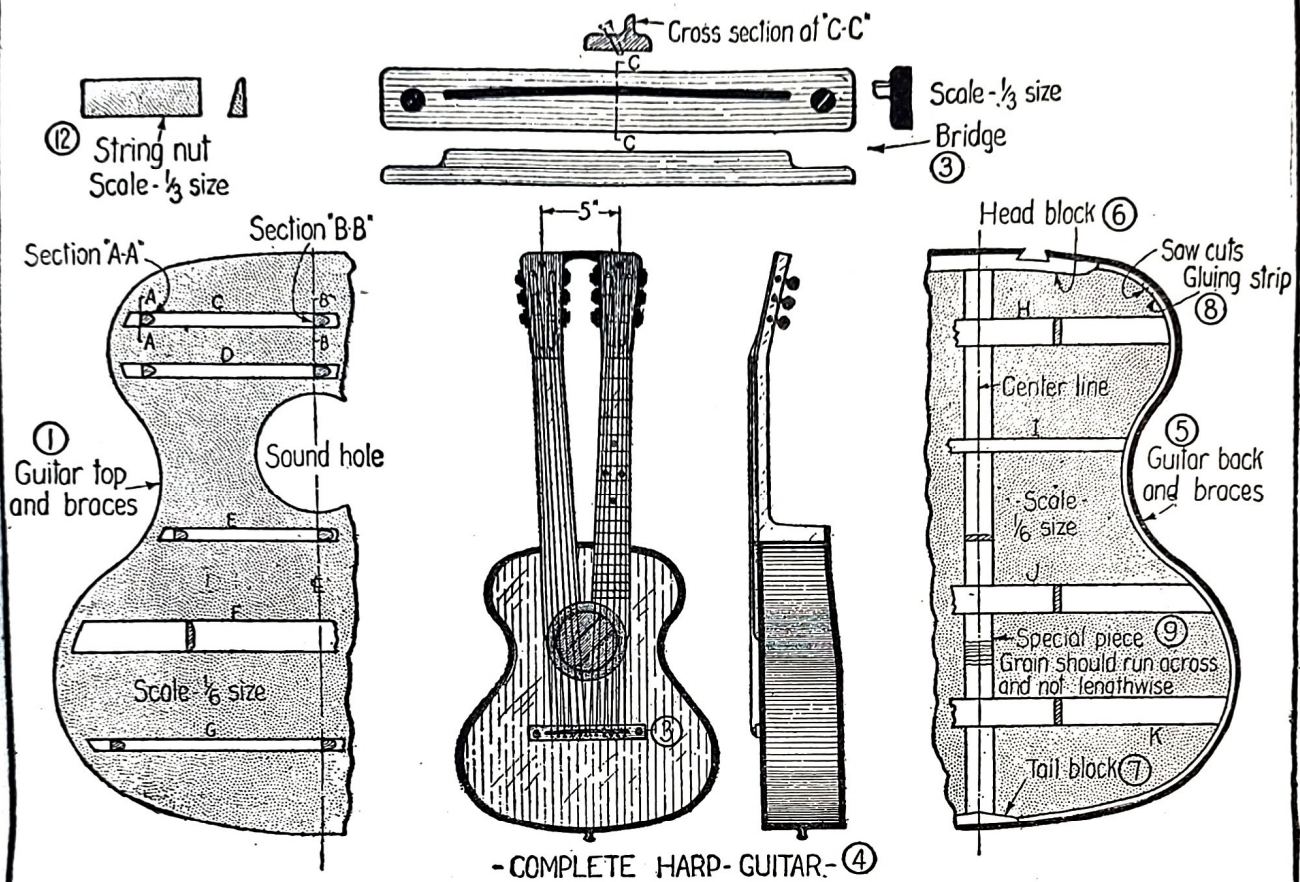
To remove material for purfling, make tools like No. 19 or No. 20. No. 19 has an adjustable cutter, the cutter is made the width of the purfling and set to required depth.

The tool is operated like a marking gauge; slivers not removed by the cutter can be taken out by a bent awl shaped to chisel edge.

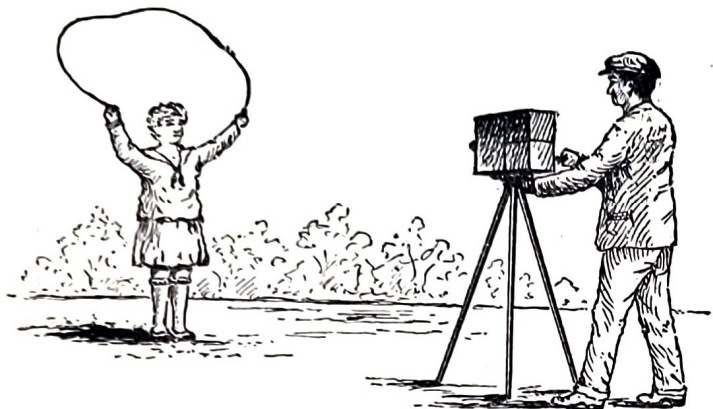
To fit strings, file very small grooves in string nuts and bridge. Be sure that the strings have a bearing at the very beginning of the grooves, otherwise they will "chatter." If string nuts and bridge are too high, file them off.

Do not have any nails, brads, screws, etc., anywhere in the body or elsewhere.

Finish the harp-guitar in varnish or shellac or any other finish desired, in order to close the pores of the wood and keep moisture out.



The Accompanying Article and the Illustration Above Explains the Details for Building a Double Neck Guitar.



Home-Made Movie Camera

By ROY A. CLAPP

EVERYONE wants a movie camera and who can think of a better way of obtaining one than to make it at home for a very small sum? The writer built the one illustrated herewith for the small sum of \$8.00, exclusive of the lens. The case is a light-tight box $3\frac{3}{8}$ " x 6" x 9". A brass plate which serves as a bearing is screwed to the side of the box as in Fig. 8. A door is provided on the opposite side, the joints being lined with velvet to exclude light. The aperture plate is made of $\frac{3}{32}$ " brass, cut, drilled and provided with guide rails as in Fig. 1. The shutter is illustrated in Fig. 2 and the bearing for the same in Fig. 3. The claw which moves the film intermittently is made of $\frac{1}{16}$ " thick brass or aluminum as shown in Fig. 5.

Two magazines which are nothing more than light-tight boxes are made to fit in back of the case and the take-up reel is fitted with a 1-inch pulley and is belted to the feed sprocket shaft. The crank is attached to the main drive gear as below. A sprocket on the cam shaft, 1 inch in diameter, drives another of the same size located on the shutter drive shaft as in Fig. 8. All of the gears and sprockets can be obtained from a motion picture supply house.

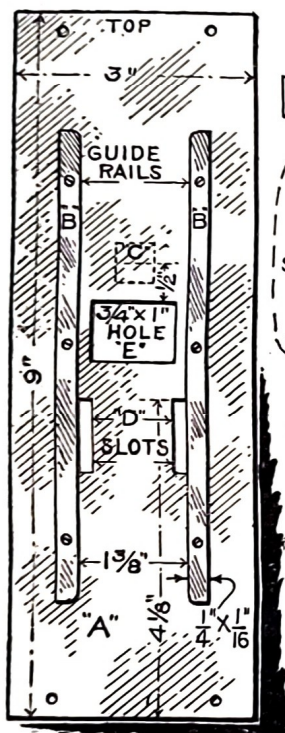


FIG. 1

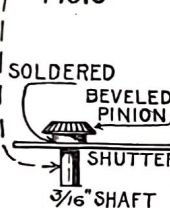
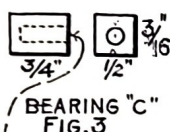


FIG. 2

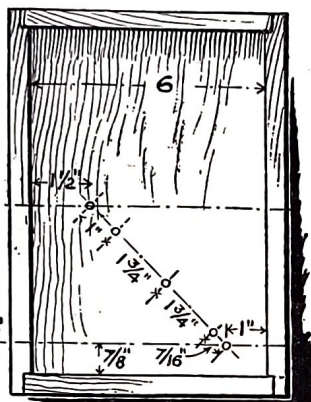


FIG. 4
WOOD CASE

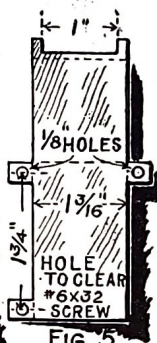


FIG. 5
CLAW

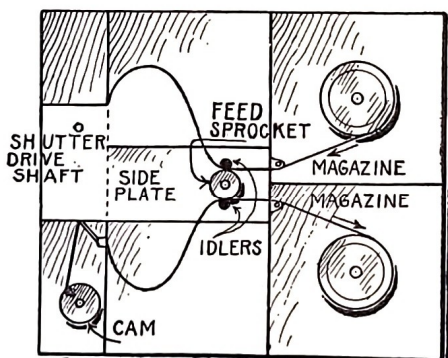
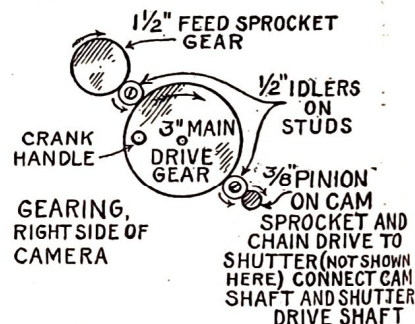


FIG. 6

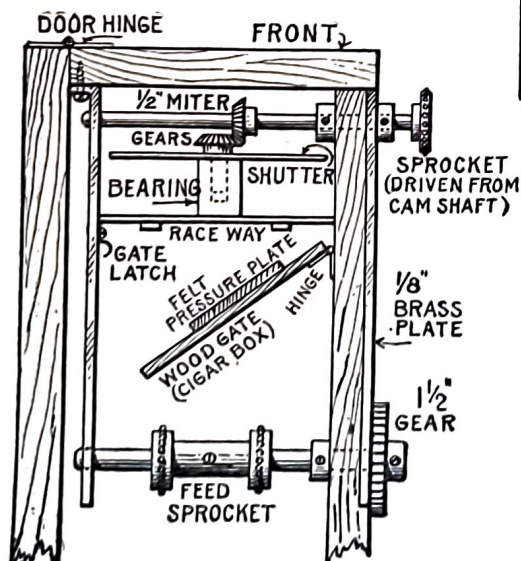


FIG. 8

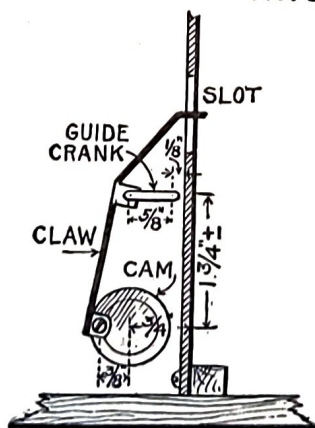


FIG. 5A
CLAW ASSEMBLY

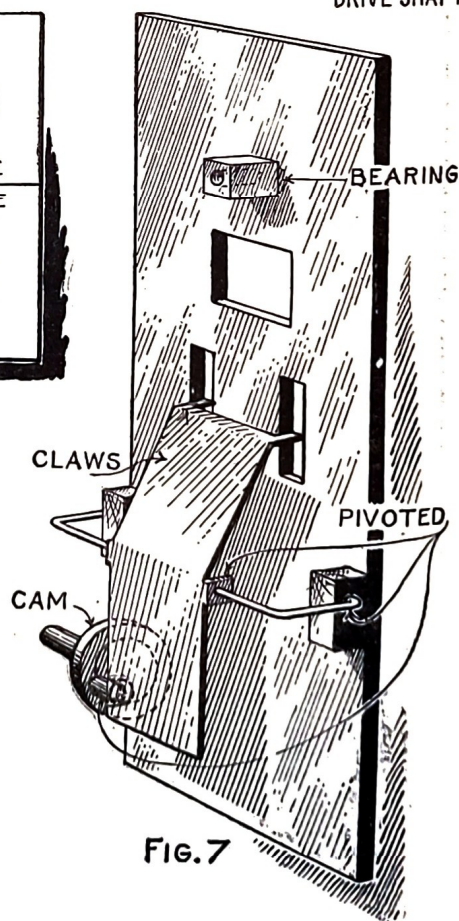


FIG. 7

A Bench-Lathe From Pipe

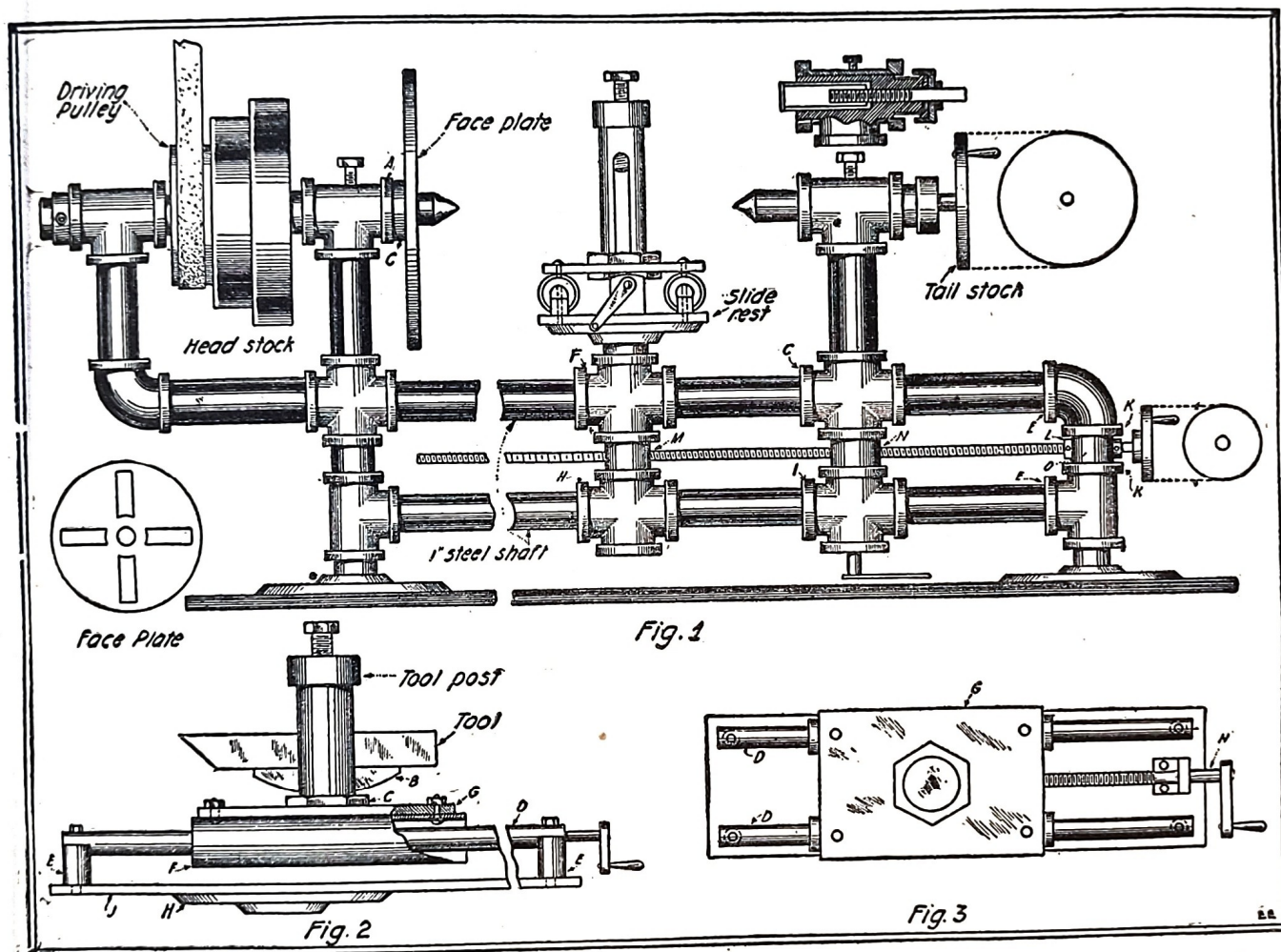
By A. NOAH HARRINGTON

I HEREWITH present drawings of a hand-made bench lathe made from pipe fittings. I made one several years ago, and it has given such good service that I thought some of the readers of *Science & Invention* would be interested in constructing such a lathe. The materials required are five one-inch crosses

babbitt will not run into them. The ends of the shafts should be *tinned* with solder to hold them firmly in place.

The feed screw is made from a piece of one-half inch shafting threaded its entire length. Holes are bored in the nipples at L and MN. A one-half inch nut is placed in the nipple at M, figure 1, before the

But a very good one can be made from a large pipe floor plate or base flange. The slide rest is shown in figures 2 and 3. J is a plate of iron $3\frac{1}{2} \times 7$ inches. A pipe floor plate is fastened to it at H, Fig. 2; DD, are pieces of one-half inch cold rolled shafting, halved out at the ends. The supports for the ends of the shafts are made



A surprisingly useful and accurate bench lathe can be built from iron pipe as here illustrated. The guides on which the tool carriage move are preferably made of machine steel, but iron pipe, carefully polished, can be used for rough work.

or double tees, five tees, two ells, four feet of one-inch shafting, ten nipples, four floor plates and a small amount of babbitt metal. The drawing needs but little explanation; E and E in Fig. 1, are pieces of one-inch shafting fastened in the fittings with babbitt. Great care must be taken to get the two pieces of shafting *perfectly parallel*! If they are not, the slide rest and tail stock will bind, and you will not be able to slide them along the shafts smoothly.

The best way to do this, is to cut two pieces of metal exactly the same length and fasten them between the shafts at dd and ee, Fig. 1. Tie them together with the slide rest and tail stock in place. Wrap one layer of thin tissue paper around the shafts where they go thru the slide rest and tail stock so they will not bind and babbitt them in the pipe fittings. The nipples should be plugged with wood so the

babbitt is poured for the feed screw to run in. Two collars can be cut from a piece of $\frac{3}{8}$ pipe, and fastened on the feed screw each side of the nipple at LK, figure 1, with pins passed thru the feed screw. A handle can be made from a pipe floor plate.

To make a good job of it, the lathe should be completely put together and carefully lined up with the feed screw in place, and then babbitted. The ends of the shafts should be firmly fastened in the fittings. The shaft for the head stock is made from a piece of one-half inch pipe turned smooth. One end is threaded for one inch, a one inch lock nut being screwed on, leaving three-quarters of an inch of thread projecting, to screw the face-plate on. The lock nut is turned down smooth to form the thrust bearing C, figure 1. The iron face-plate was cast from a wooden pattern and turned up in the shop.

from pieces of one-quarter inch pipe; FF, are two pieces of one inch pipe, $3\frac{1}{2}$ inches long, fastened to the plate G with machine screws. They are placed on the shafts DD, Fig. 2, and babbitt poured in them around the shafts, first wrapping a piece of thin tissue paper around the shafts, so they will not bind. The plate G, Fig. 2, is $3\frac{1}{2} \times 3 \times \frac{1}{4}$, with a one inch hole in the center for the tool holder or post. The tool holder A, is made from a piece of one-half inch pipe. A slot is cut in it to hold the tool and a cap is screwed on the end thru the center of which a hole is bored and threaded for a $\frac{1}{8}$ cap screw. It is fastened to the plate A with two lock nuts, one above and one below the plate.

A curved piece of iron, B, is placed under the tool to raise and lower it. The feed screw is shown at H, Fig. 3.

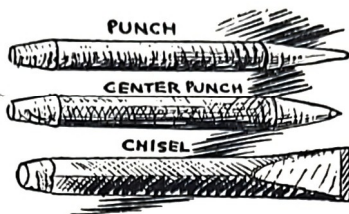
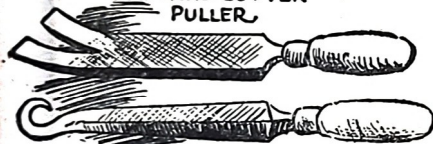
Tool Set from Old Files



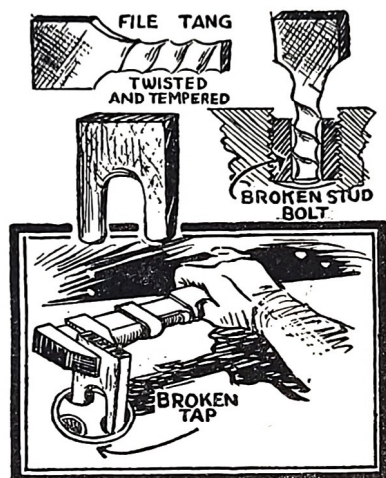
SCRAPERS



NAIL AND COTTER PULLER



EXTRACTORS



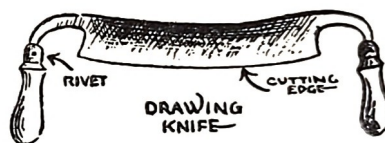
DRILL FOR GLASS



DRILL FROM ROUND FILE



LARGE FLAT DRILL

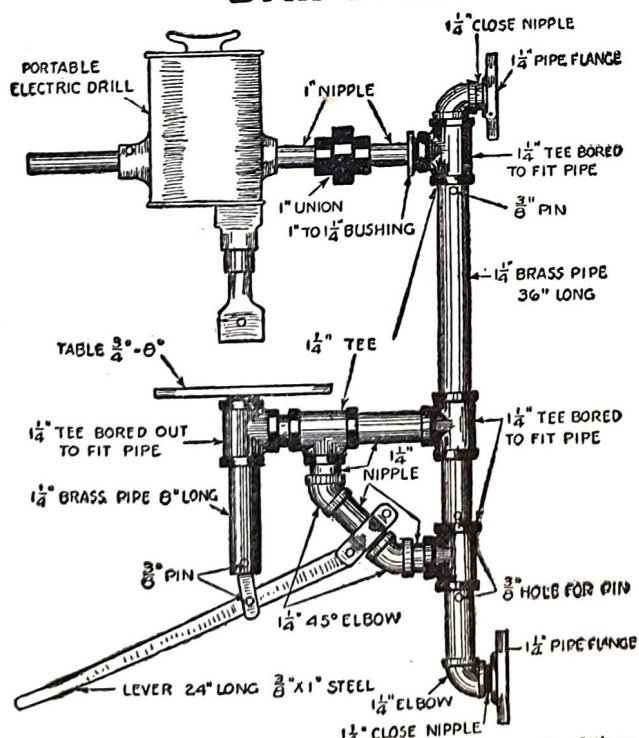


DRAWING KNIFE

The system of using the metal of old files for the construction of tools has long been known to mechanics. However, a few adaptations are shown in this article which have not before been generally known. In all

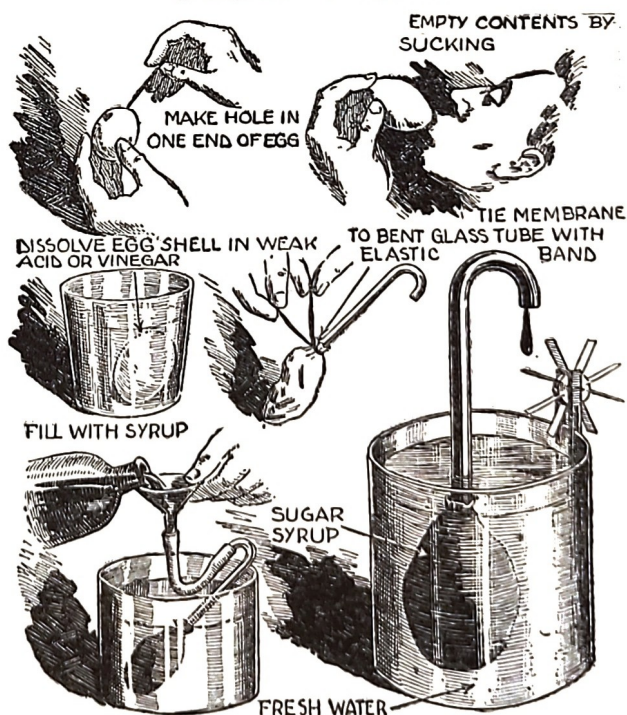
cases above the temper is drawn from the file, then it is ground into shape and retempered. For all the instruments except the glass drills use a light straw temper; for the latter, use a deep purple.—G. A. Luers.

Drill Press



The drill shown above was made of standard 1 1/4-inch brass pipe fittings equipped with a standard electric drill as the power unit. The work is adjusted by raising the table with the aid of the lever. The pins in the main frame adjust the height roughly. Brass pipe will be found best. —Harry B. Luessen.

Sugar Motor



Osmosis is responsible for the operation of this motor. A small hole is made in one end of an egg and the contents sucked out. The shell is dissolved away with vinegar or weak acid, and the membrane sack attached to a hooked tube. If the sack is filled with sugar syrup, osmosis will cause the liquid to rise through tube running wheel.—Dr. R. G. Harris.

Bench Drill from Pipe Fittings

By R. E. NELSON

THE accompanying photograph shows a bench drill which the writer constructed from scrap pipe fittings and odds and ends about the shop. Cast fittings should be used as they add to the rigidity of the frame. The photograph shows the motor mounted on a box over the rear bearing but its position may be varied to suit the builder. A snap switch with fuse block mounted on the side of the box controls the motor. Five-sixteenths or $\frac{3}{8}$ " round leather belting is large enough to drive the drill to full capacity.

Frame

For the frame the following pipe fittings are required:

- One-half of a $1\frac{1}{2}$ " Flange Union—"Y" fig. 2.
- 1 Nipple $1\frac{1}{2}$ " x $10\frac{1}{4}$ " E. H. Pipe—"Z" fig. 2.
- 1 Nipple 1" x 5" E. H. Pipe—"U" fig. 2.
- 1 Nipple $\frac{3}{4}$ " x $4\frac{1}{2}$ " E. H. Pipe—"N" fig. 2.
- 1 Nipple $\frac{3}{4}$ " x $4\frac{3}{4}$ " E. H. Pipe—"N" fig. 2.
- 1 Cast Tee $1\frac{1}{2}$ " x $1\frac{1}{2}$ " x $\frac{3}{4}$ "—"X" fig. 2.
- 1 Bushing $1\frac{1}{2}$ " x 1"—to fit top of "X."
- 2 Cast Tees $\frac{3}{4}$ " x $\frac{3}{4}$ " x $\frac{3}{4}$ "—"C" and "C."
- 1 Cast Tee 1" x $\frac{3}{4}$ " x $\frac{3}{4}$ "—"Q" fig. 2.
- 1 Piece 2" x 8" x 24" Oak S4S for Base.

Cut and thread the nipples as per dimensions in figure 3 and assemble the frame. Bolt it to the oak base and test it for rigidity and alignment. Larger fittings can be used by bushing them down in case the above sizes are not obtainable. When in its lowest position the chuck is $4\frac{1}{2}$ " from the base and as no table has been provided for bringing the work toward the drill, a few wood blocks of various thickness should be provided for adjusting the work to the proper height.

Chuck and Spindle

The chuck "A," figure 2, should be purchased as it is beyond the scope of the amateur. Get one that has a $\frac{1}{2}$ " shank which screws into the top of the chuck body and operates the jaws. This shank should be removed and the spindle threaded to fit in its place.

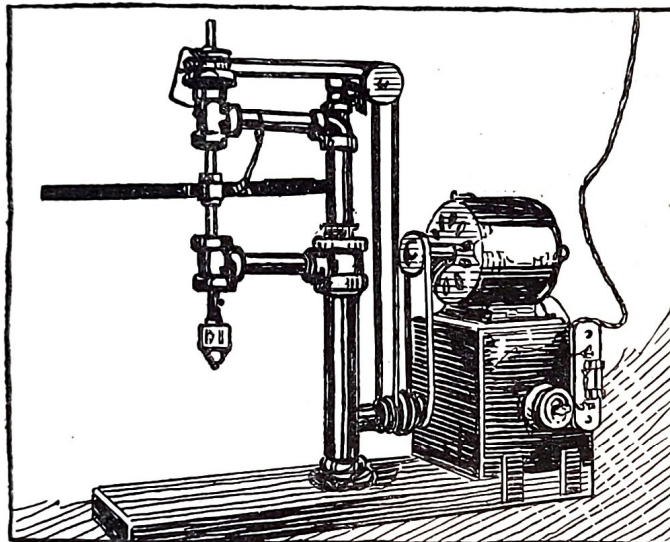
The spindle "B," figure 2, is turned from machine steel to dimensions shown in figure 3 and a keyway is cut in the upper end as shown. The spindle slides up and down thru the pulley "H" while the key "I" is relied upon to drive the spindle. The lower end of the spindle is threaded to fit the particular chuck purchased. The spindle pulley "H," figure 2, is shown in detail in figure 3. The best material to make it from is cast iron or brass. A $1/16$ " x $\frac{3}{8}$ " keyway is cut in the pulley to correspond with the one in the spindle. Make the key "I," figure 3, next and make it fit very tightly in the keyway of the pulley but have it fit loosely in the keyway in the spindle so that the spindle can be raised and lowered while the pulley "H" is driving it. As a further precaution to prevent the pulley "H" from rising when the spindle is raised make a small piece "G," figures 2 and 3, and fasten it to the upper tee with machine screws.

An easy way of cutting the keyways in the spindle and pulley is as follows: While the work is still between centers or in the chuck place a cutter with a $\frac{1}{8}$ " face side-

ways in an Armstrong holder or boring bar so that the cutting edge is toward the headstock. Run the carriage back and forth by hand and at the same time advance the cutter and a perfect keyway will be cut. Care must be taken to lock or clamp the headstock spindle so that it cannot rotate or shift its position even so much as a $1/100$ of an inch or the keyway will be imperfect.

Feed Device

The easiest feed device to construct is a



The Finished Bench Drill Constructed From Pipe Fittings.

lever feed. It consists of the following parts: the lever "F," figures 2 and 3, which is hinged to the piece "P" by a stove bolt, two collars "D" and "D'" which are pinned to the spindle and the collar "E" which fits loosely between them but is not pinned to the spindle and does not rotate with it. Collar "E" has two projecting pins fastened to it (figure 3) which engage in the holes "O" and "O'" of the lever. The feed device operates as follows: When the lever is pressed down, the two pins which are fastened to the collar "E" and which engage in the holes "O" and "O'" of the lever, cause the collar "E" to move down with the lever, but, the collar "E" bears against the collar "D" which is pinned to the spindle, and consequently the spindle is fed down with the lever. When the lever is raised collar "E" bears against the upper collar "D'" and the spindle is raised.

Make the lever "F," figure 3, by riveting two pieces of $\frac{1}{8}$ " x $\frac{3}{4}$ " strap iron together. The loop is made by bending the pieces around a $1\frac{1}{4}$ " bar. The $\frac{1}{4}$ " holes "O" and "O'" in which the pins and collar "E" engage are drilled on opposite sides of the loop as shown. Drill two $\frac{1}{4}$ " holes in the end of the lever where it hinges to the piece "P" and file them out to form a slot. Unless this is done the holes "O" and "O'" will describe an arc and the spindle will bind. Make the anchor piece "P" from a piece of strap iron and fasten or clamp it to the nipple "U" with machine screws or a stove bolt. A stove bolt will do to hinge the lever on. A small spring keeps the spindle raised when the lever is released.

The two collars "D" and "D'," figure 3, are similar and are turned from brass. They should fit the spindle very snugly. Turn up the collar "E" from brass also and have it fit loosely over the spindle.

Drill a $\frac{1}{4}$ " hole right through the collar edgewise and fit two pins in it letting them project about $\frac{1}{2}$ " to engage in the holes "O" and "O'" of the lever. To locate the position of the collars "D" and "D'" on the spindle proceed as follows: place the collar "D" on the spindle with its lower face 9" from the upper end of the spindle; and over it place a washer made from heavy paper. Next put the collar "E" in place and put another paper washer over it and then put collar "D'" on top. Clamp the

three collars together and drill a $\frac{3}{8}$ " hole edgewise thru collar "D" and slip a pin in it to keep the assembly in place and then drill a similar hole in collar "D'." Remove the clamp but do not remove the pins so that the location of the collars will not be disturbed until the spindle is finally put in place. If it becomes necessary to remove the collars for any purpose be sure to mark them with punch marks or otherwise so that they can be put back in the same position that they occupied before. It will, of course, be necessary to remove the paper washers before the drill is run.

Belt Tightener

The belt tightener and idler device consists of a plug "M," figures 2 and 3, threaded to fit the top of the tee "Q" and slotted as shown. In the slot is clamped the carrier "K" which holds the shaft "L" on which two pulleys, "J" and "J'," rotate in opposite directions. Make the plug "M" from brass or soft steel and thread it to fit the tee "Q." Cut a slot in it as shown in figure 3 and drill a hole for a clamping bolt. The carrier "K" is made from soft steel and slotted as shown in figure 3. A $\frac{3}{8}$ " hole is drilled at the large end for the shaft "L" which is a piece of $\frac{3}{8}$ " round soft steel polished up and threaded at each end for a nut. It should be driven into the $\frac{3}{8}$ " hole in the carrier "K" and pinned if necessary so that it will not rotate. The two pulleys "J" and "J'" are similar and should be made from brass, iron or hard babbitt. They should rotate freely on the shaft "L."

Drive Shaft

The drive or countershaft parts should next be constructed. There are five parts to these: a shaft "T," is supported at each end by the bearings "S" and "W" which are described in detail later on.

Turn up the shaft "T" from soft steel as per dimensions in figure 3. The three-step cone pulley should next be turned up from a piece of cast iron or brass or hard babbitt. The babbitt is just as good as the cast iron or brass and can be easily cast in the home work-shop. It is also very easy to machine. The detail dimensions are shown in figure 3. Hold the casting in a chuck or clamp it on a face plate and bore a $7/16$ " hole thru the center. With an inside boring tool bore out the diameter to a scant $\frac{1}{4}$ " or just enough so that the shaft "T" will fit very tightly in the hole. If this is done it will be unnecessary to use pins or set screws to fasten it to the shaft. Use the same method in turning up the pulley "V," or if desired, both pulleys may be turned in one piece.

(Continued on page 24)

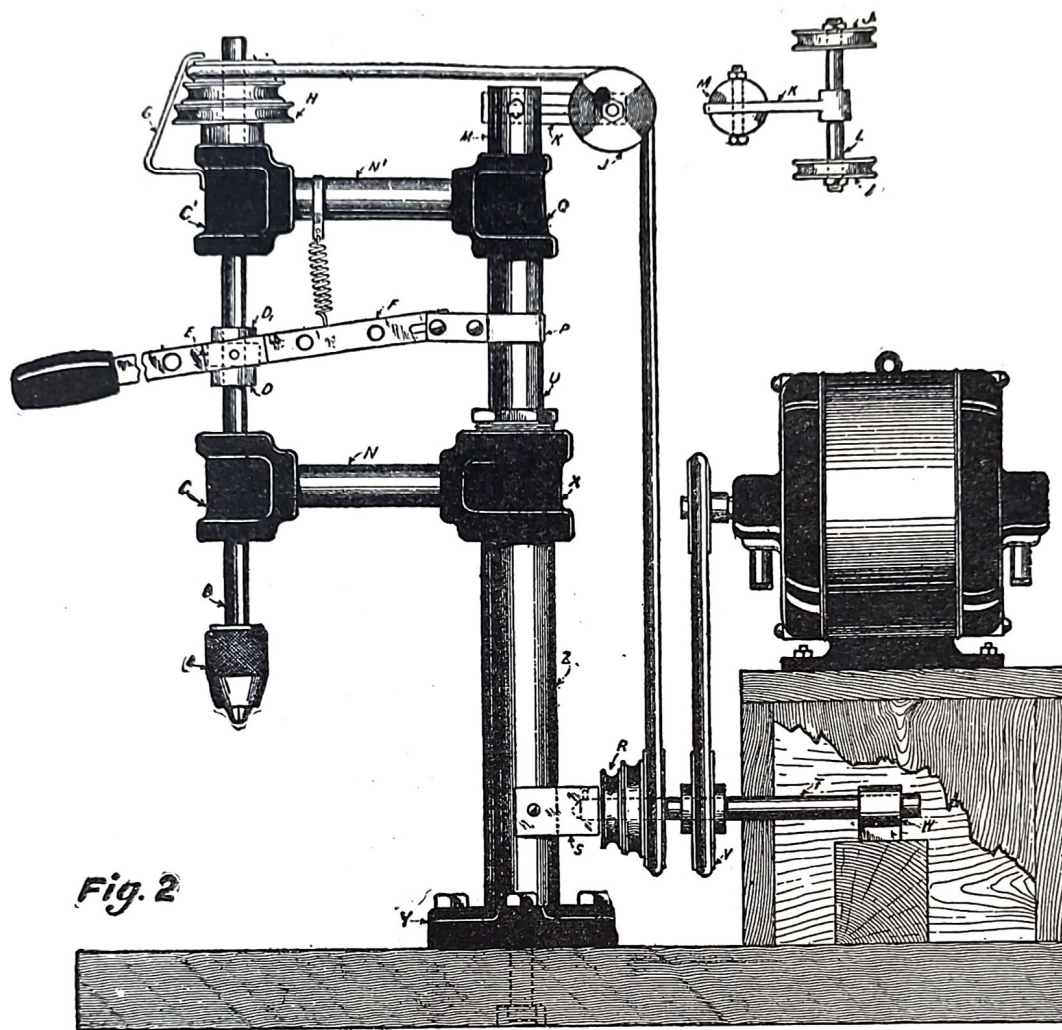


Fig. 2

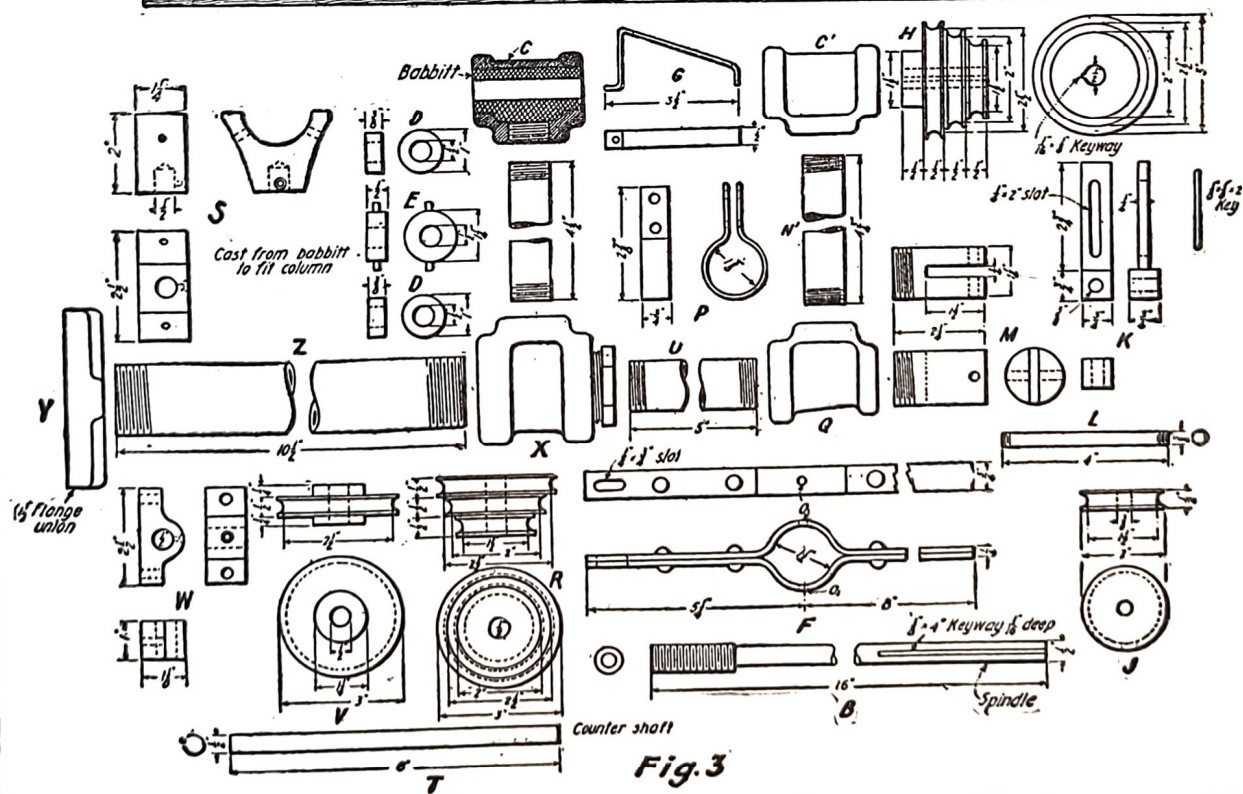


Fig. 3

Building "Your Own" Phonograph

PART I

Full Details Describing How to Build Motor, Turn-Table, Tone Arm, Reproducer and Sound Chamber

TODAY, the phonograph or talking machine has become so much simplified and standardized, and there are such a great variety of parts available on the market, that many people have found great pleasure in building their own phonographs.

In the present article, the writer will endeavor to present the practical aspects of building one's own phonograph, which he has learned thru considerable experience in building several of his own, one of which is used for parlor use and two others for laboratory experimental work, where "looks don't count."

One of the main things to be considered in building your own phonograph, usually, is that you do not want a cheap looking machine so far as external appearance is concerned, if it is to be used in the parlor or living room for family entertainment. It is very simple now to purchase a small table cabinet at a cost of a few dollars, up to a full size 50" floor cabinet with sound chamber already built in it for the price of anywhere from \$25.00 up to \$50.00 or more, depending upon how ornate a cabinet you may desire. Then to tickle the heart of the "how-to-make-it" bug, there are dozens of different makes of motors, tone arms and what not, available from numerous dealers.

However, an effort will be made in the present treatise to provide sufficient instruction and detail so that those who like to feel the real thrill and enjoyment of building the "whole works" and perhaps the cabinet too, can do so; as the only things you cannot make just yet, are the records.

Something About Phonograph Motors

A typical high grade phonograph motor is shown at Fig. 1, and if you are not already familiar with the operating features of such a motor, you can learn a great deal by carefully studying this drawing. Practically all regular phonograph motors are of the spring propelled type, and contain anywhere from one to four or more barrels or cylinders in which are placed powerful steel springs about the size of those in an 8-day clock, but somewhat longer, which are packed in graphite and oil. The power is transmitted from the springs once they have been wound by means of the handle and ratchet in the well-known manner, to a train of toothed gears and which include an automatic speed governor and regulator. Details of this speed governor which you may want to build yourself, if you already have some other form of power such as an electric motor or a gravity motor for the purpose of rotating the turn-table, are given at Fig. 2.

Phonographs, like every other piece of machinery, should be kept oiled at all of the bearing points and about once a year it is well to see that the springs are thoroly lubricated and packed in graphite and oil, which mixture is available from phonograph manufacturers. New springs are also available from these companies or thru phonograph dealers. It is important to note in connection with the phonograph motor shown at Fig. 1, that the main turn-table shaft doesn't rest on its regular shoulder bearing, but has a foot-step or pivoted bearing placed under it, which is fastened to the main frame.

It is surprising what a difference this makes, as the writer found in improving a small spring motor which he used in his first experimental machine. When the motor would run a 10-inch record scarcely at all, the same motor ran off the record in fine style, when a polished steel plate bearing was rigidly secured under the lower end of the main turn-table shaft, the end of this shaft being rounded off or crown shaped. And of course, if you take the trouble to make a cup-shape bearing under the shaft, and place a ball-bearing on it, you will get still better results.

With regard to the automatic speed regulator and governor you will soon learn, if you are not already familiar with phonograph matters and phonographs in general, that one of the most important things is that the speed of the turn-table must be as constant as possible, and further—that you will want to change the speed now and then

MAKING PHONOGRAPHS

TO build your own phonograph, may sound like a very difficult problem to those who have never experimented in this direction before, but once you have started and succeeded in building your first model, you will find it one of the most fascinating and interesting endeavors you have yet ventured into. Just to build your own phonograph is not the whole story, as there is a good opportunity to build phonographs for others. There is one fine feature about building your own phonograph today, and that is you do not have to experiment and develop your own motor, or in fact your own tone arm or anything else among the machine parts proper, as these can be readily obtained from the innumerable phonograph supply companies.

The future of the phonograph is thoroly assured, but not with the present type of machine, it is prophesied by scientists and engineers; who predict that the talking machine of tomorrow will be a marvelous mechanism indeed, not only for its simplicity but for its purity of note and fidelity of reproduction of the human voice. The experimenter of today, therefore, has one of the finest opportunities ever given to anyone to invent something "real new" in the realm of talking machines. The present talking machine is not perfect by any means, and the "germ" of the perfect talking machine which everyone desires, has yet to be discovered.

for various records. The average speed for flat disc type records, is about 68 revolutions per minute. This can be timed either by means of a speed indicator held in contact with the center stud of the turn-table as it revolves, or else by placing a chalk mark on the felt cover of the turn-table and counting the revolutions for a half or full minute by means of your watch. If you cannot procure a governor to use in connection with your electric or gravity motor, or perhaps to regulate the spring motor such as that from a large discarded clock movement, etc., you can, with a little ingenuity, readily build one. Details of the standard three-ball governor are shown clearly at Fig. 2.

Two brass collars are usually made, which fit the shaft with a very even clearance. One of these has a set screw threaded thru it so that it can be secured tightly to the governor shaft, while the other collar has a perfectly flat brass or steel disc about 1/16" thick and 1 1/2" in diameter, rigidly

secured to it. Both hubs should have three spots filed on them at exactly 120 degrees apart, and three holes drilled and threaded in each for about No. 6-32 thread machine screws, to be used to hold the ends of the three steel governor springs as shown in the figure. For a small size governor, these springs may be pieces of corset steel, etc., and may measure about 5/32" in width by 1/64" thick. The weights on them may be round or of cylinder shape and if made of lead, steel or iron, they may measure about 7/16" in diameter by 3/16" in thickness. These weights must be secured to the exact center of the three governor springs, either by riveting or by means of a 6-32 screw threaded into the weights.

The speed control lever with its felt brush is shown clearly in the drawing and this presents no difficulty in construction. The action of the governor is now quite apparent, the three balls or weights tending to fly outward and make a larger circle as the motor speeds up, and vice-versa by moving the speed regulator screw. The felt shoe bearing against the brass disc mounted on the free hub of the governor will retard the further movement of this disc, so that the weights can only fly out a certain distance and thus keep the speed down to whatever limit may be desired. The hub at the opposite end of the governor is tightly secured to the shaft and it is best to "spot" the shaft with a drill or file where the set screw is to rest.

Building a Gravity Motor

One of the finest motors used in telegraph recorder and similar work, is the gravity operated motor. This motor, for one thing, possesses the characteristic of giving very constant speed, more so than the spring motor where the power of the spring is constantly decreasing as the motor unwinds. The force of gravity or pull exerted on a given weight is constant, and thus, as long as the weight is in action, the pull exerted on the gears and turn-table or other devices propelled by the gears, is constant also.

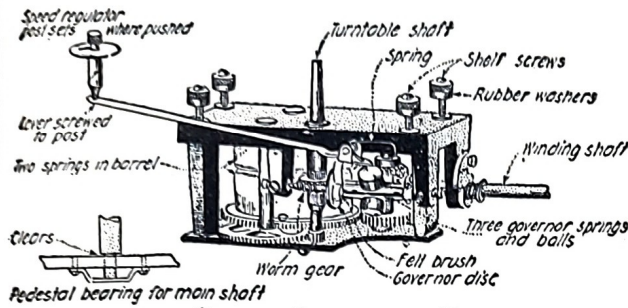
Fig. 3 shows the principal parts which may be used in building a gravity motor. The gears may be the same or in fact the identical gears in an old phonograph motor, or other mechanism. You will require either the two-ball or preferably the three-ball governor to keep the speed under control, and even. The weight used to actuate the motor may comprise one large size boulder (Belgian blocks will do just as good work) also pig-iron or any other good hefty scrap. Even a large can of water, etc., or pail full of sand can be used.

The whole secret of the gravity motor is this: You wind up the heavy weight, say 50 to 75 pounds, slowly, by means of the handle attached to the ratchet and drum, but no ratchet is required if you do not happen to have one, and this weight moves very slowly in its downward descent.

You can usually figure out the ratio of the gear teeth and the comparative drop or fall of the weight for any train of gears, by consulting any machine shop or mechanics' manual.

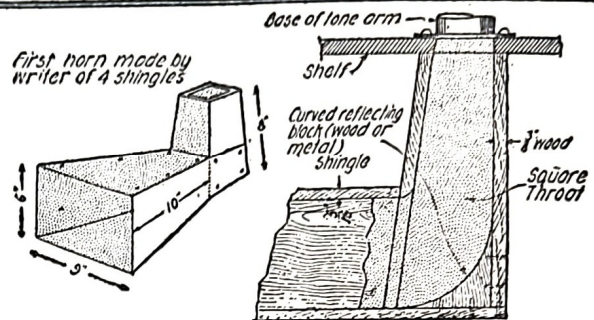
The governor can be mounted on its own shaft and geared to the main train of gears as shown in one of the figures, or it may

BUILDING "YOUR OWN" PHONOGRAPH



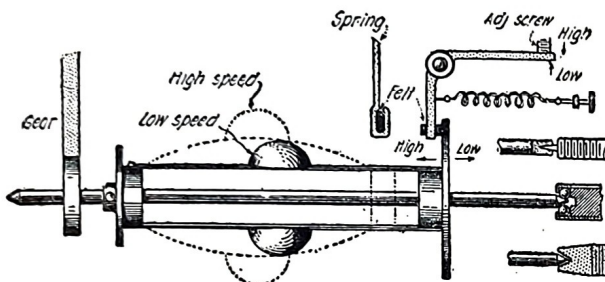
TYPICAL PHONOGRAPH MOTOR

-1-



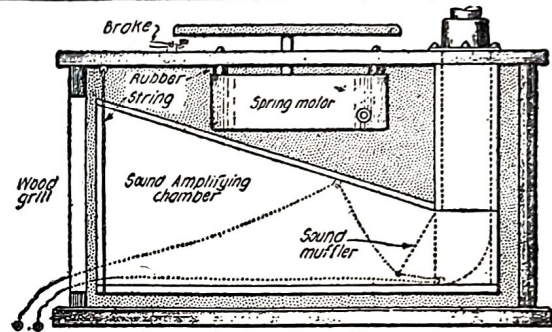
THE SHINGLE SOUND CHAMBER

-6-



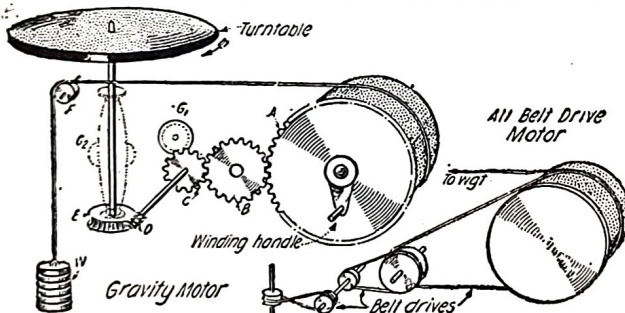
DETAIL OF PHONOGRAPH GOVERNOR

-2-



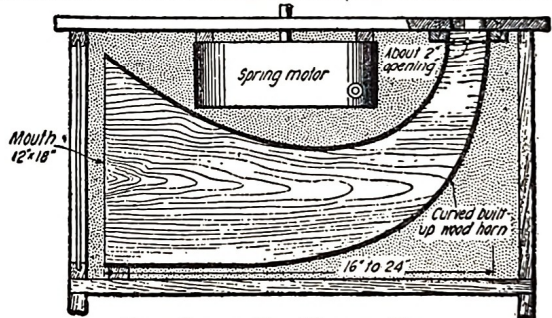
SOUND CHAMBER IN CABINET

-7-



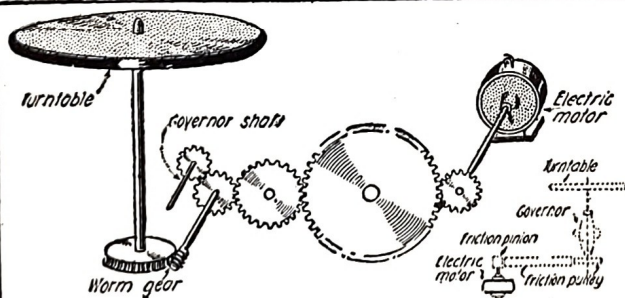
GRAVITY MOTOR

-3-



BEST SHAPE FOR WOODEN HORN

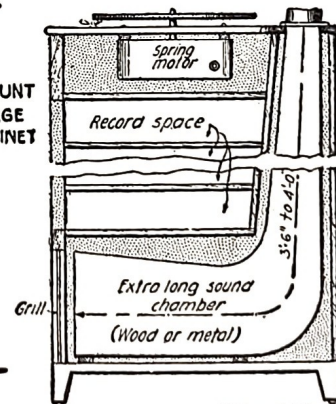
-8-



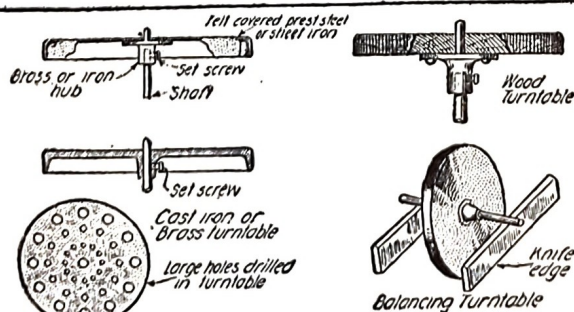
ELECTRIC PHONOGRAPH MOTOR

-4-

HOW TO MOUNT
EXTRA LARGE
HORN IN CABINET

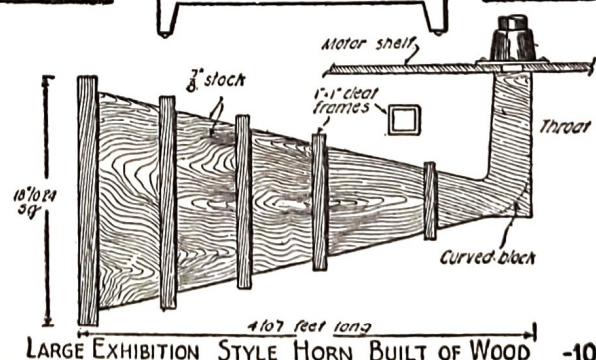


-9-



VARIOUS STYLES OF TURNTABLES

-5-



LARGE EXHIBITION STYLE HORN BUILT OF WOOD

-10-

be mounted on the main turn-table shaft; and there are several other ways in which it can be connected to the main gear train so as to regulate the speed.

Electric Motor Drives

Fig. 4 shows two ways in which electric motor drives for phonographs can be used. The first method involves the connection of the electric motor to the gear train directly, with the use of the usual speed governor and regulator. The second method is a pure friction drive and this has been used to some extent commercially with very good success. The periferics of the friction pulleys may be covered with leather or they may be fiber pulleys, etc. Needless to say, the three-ball governor should be linked up with the driving train at some point, so as to keep the speed even and also to regulate the speed to the desired value.

Fig. 5 shows several stages in making your own turn-table. The standard turn-table is formed of pressed steel about 3/64th inch thick, the edge being rolled over about 7/16"; the top of the turn-table is covered with a piece of green or other colored felt glued to the metal, and at the exact center a brass or iron hub is riveted or screwed to the steel table. The hub is usually turned up from a piece of iron or brass in a lathe, so as to contain the pin at the center which passes thru the center of the record, while the hole at the bottom of the hub accommodates the driving shaft.

In standard phonographs no set screw is required as this hole in the base of the hub is tapered to accommodate the tapered shank on the upper end of the shaft. In home-made turn-tables, a set screw is invariably threaded thru the side of the hub so as to secure the turn-table rigidly to the shaft. The turn-table can be very well made of wood about one-half inch thick and a standard diameter for turn-tables is 12 inches, altho if you have a small motor which will not rotate such a large turn-table a small one, say about 10 inches in diameter, may be used. Some makes of machines employ a cast iron or brass turn-table as shown at Fig. 5, the flat part of the table being cast with a large number of holes over its entire surface to reduce the weight.

For best results and in all first-class machines, the turn-table is *balanced*. This is performed very simply by mounting the table on a shaft which projects thru about four inches on the outer side. Two straight edges, preferably steel knife edges, are leveled up by means of a spirit level in both

directions, and the turn-table with its shaft then placed on the knife edges. Holes are drilled in the turn-table or else solder placed on the rim, etc., until the table will rest in any position you place it without manifesting any turning effort. In other words, it must stand at any point you turn it to, without moving.

Building the Sound Chamber

When it comes to sound chambers there are many varieties of them, but as Prof. Dayton C. Miller, one of the foremost experts in the physics of musical sound in America, recently pointed out to the writer, —what we desire in a phonograph sound chamber (just now we mean the main amplifying sound chamber extending from the base of the tone arm, out to the grill), is an air-tight, solidly built chamber of standard size, so that the column of air within this chamber can be vibrated at any frequency desired, such as by musical vibrations impinged upon it by the phonograph reproducer or sound box.

Looking at Fig. 6, we have the simplest imaginable form of phonograph sound chamber which is not a very remarkable affair it is true, but at least, the writer had the pleasure of building one just like this, out of four wide shingles. And it has served its purpose very well indeed, and in fact is still doing duty in his laboratory phonograph, used for carrying on telephonic and other tests. The reader will see at a glance just how this horn is built—the bottom is a flat shingle cut so as to taper toward the back; the two side shingles were cut straight along the bottom and taper from the outer top end down to within about 2½" at the back, where they run out so as to form a base by which they can be nailed with brads to the lower sides of the wooden throat member. The top shingle is cut tapered on both sides so as to just cover the top of the chamber tightly and rest firmly against the front of the throat chamber. The down-coming throat chamber is built of ¾" wood (oak in the author's case).

All joints are planed smooth with a carpenter's plane and then glued and nailed with a few small brads. Do not be afraid to use a few brads in building the horn, altho many people will tell you there should not be a brad in it.

The main thing to be observed in building any sound chamber is as aforementioned, that it should be as nearly *air-tight* as pos-

sible from end to end, as Prof. Miller pointed out, since if there are any bad leaks or air holes in the chamber, there will be set up false notes or vibrations, or else a weakening of certain harmonics in the vibrations, at the points corresponding to the wave-length location of those air holes or leaks along the chamber.

Be careful therefore in drilling holes in the side of the chamber for the purpose of fitting sound valves and mufflers, etc. If you must do this, make the joint absolutely tight by using brass bushings tightly mounted in the woodwork and a tight-fitting shaft thru these bushings.

Fig. 7 shows a wooden sound chamber of the type illustrated at Fig. 6, mounted in a cabinet of the table type.

When it comes to building a first-class wooden sound chamber, Fig. 8 shows the "Daddy" of them all. All of the best phonographs have a chamber shaped something after this fashion and of course, it is evident at a glance, that this is an ideal form. The air waves can expand and amplify in this chamber, without having to break around any sharp corners, as the curve is a steady and smooth one. The amateur cabinet maker may find it quite difficult to build a chamber of this form, but it can be built by a cabinet maker or else you can have one made by a carpenter for a nominal sum. The wood used may be mahogany or some other fairly hard wood, about ¾" to 1½" thick, altho many commercial phonographs have sound chambers of this shape built of wood ¼" thick or less. Prof. Miller states that the horn should be built of sufficiently heavy wood, so as not to vibrate but to keep the column of air "rigid," so to speak, in order that only this column of air should be vibrated by the sound waves impressed upon it at its base, by the *reproducer*.

Large Sound Chambers

When it comes to large sound chambers there are often cases where the reader will like to experiment with this, or one somewhat like it that will produce an extra large volume of sound. Figs. 9 and 10 show two examples of ultra-large sound or amplifier chambers which can be made of metal or wood—the writer prefers wood. The arrangement shown at Fig. 9 is a very clever one and it shows how one phonograph manufacturer has designed his cabinet so as to accommodate an amplifying chamber over four feet long.

Bench Drill from Pipe Fittings

(Continued from page 20)

Babbitting Spindle Bearing

After these parts have been completed the next step is to babbitt the spindle bearings. This requires very careful work as the accuracy of the drill depends upon it. First bolt the frame to the base board. Next cut four pieces about 2½"x2½" out of 1" soft pine. With an expansion bit bore a hole *one-half* of the way thru each piece of such a size that the ends of the tees "C" and "C'" will just fit snugly in the holes. With a ½" bit bore a hole the rest of the way thru the blocks. Fit one block on the top and bottom of each tee and then push the spindle thru these holes. After the spindle has been lined up cut a pouring lip on the top block of each tee, or, if the builder desires it, the top block on each tee may be left off entirely and the lower block on each tee relied upon to hold the spindle in alignment. Before pouring the babbitt be sure to plug the nipples "N" and "N'" with something (clay or putty), to prevent the babbitt

from running down in the frame. Both bearings should be poured at the same time to prevent the spindle from springing or warping. A little white lead smeared on the spindle will prevent the babbitt from sticking to it. When the metal is cool drive out the spindle and polish it up. If the bearings are tight turn the spindle by hand using plenty of oil until they loosen up. Cut oil grooves in each bearing and drill an oil hole at the top of each tee and fit an oil cup.

The final step is to assemble all of these parts and give the drill a trial run. Whether or not the spindle runs true and free from wobble depends upon the workmanship as a whole. In conclusion it may be well to state just what may be expected of the drill. The writer is using a drill as described for the usual run of light work and it is giving fine service. It will drill a ½" hole in soft steel with ease, and when working in fibre and softer materials a ½" hole can easily be drilled.

Drive the shaft in place in the pulleys and using the shaft as an arbor, true the outside diameters of the pulleys and face the sides off in a lathe.

If different spindle speeds are desired it will be necessary to change the sizes. The pulleys shown in the drawings give spindle speeds of approximately 2,300, 1,400 and 840 R. P. M. when the motor runs at 1,750 R. P. M. I purchased a ¼ H. P. washing machine motor which came equipped with a 2" grooved pulley and I did not alter the size of this.

The easiest method of supporting the shaft "T" is to make two bearings from cast babbitt, one as shown at "S," figures 2 and 3, to fit around the main column "Z"; and the other in the shape of a small pillow block as shown at "W," which can be mounted on a wooden block of the proper height. Oil holes should be drilled in the top of each bearing, or else oil cups should be fitted to properly lubricate the shaft.

Building "Your Own" Phonograph

PART 2

Full Details Describing How to Build Tone-Arm and Reproducer

IN the first part of this article describing how to build your own phonographs, the important details of motors and speed regulators, as well as sound chambers or horns, were described in complete detail. In the present article, we will concern ourselves with one of the most vital parts of the talking machine, namely, the tone-arm and reproducer, or, as it is sometimes called, the *sound-box*. In this category also comes the consideration of modulators or sound muffers, for regulating the strength of the sound transmitted thru the horn or amplifying chamber to any degree desired.

The Simplest Reproducer

For those interested in the experimental side of phonography, reference may be had to Fig. 1, where two of the simplest talking machine reproducers are illustrated. The one at the left comprises an ordinary wooden shingle, the harder the wood the better, and in one corner of which is pushed an ordinary steel phonograph needle. The writer has tried this with very interesting results, the entire shingle vibrating with sound and giving very articulate reproduction of the music. The shingle may be held between the fingers at the upper corner, or else suspended and balanced carefully on a thread or string, when it will be found that the groove on the record will propel it across the latter as the turn-table rotates.

One of the earliest forms of reproducers and sound amplifiers is that shown at Fig. 1, and this may still be found on some of the cheap phonographs sold on the market today. Here the horn is suspended or pivoted so as to move freely across the record when propelled by the needle in the groove, while the diaphragm, composed of mica or fiber, etc., is firmly clamped between two rings, or else spun into a ring, at the smaller end of the horn. A suitable stylus arm is usually fitted in the manner shown and standard needles are used.

Speaking of Tone-Arms

Figures 2, 3, and 4 show three distinct, yet different, ideas in the construction of tone-arms. One of the most important features to be watched in any phonograph tone-arm is the *weight exerted on the stylus needle*, and in turn upon the record groove. This must not be too great, or the records will soon become "choppy," owing to the breaking up of the grooves, and also due to wear and scratching. Some tests made on a number of standard phonographs by the writer, brought out the following facts, which will be of interest to all phonograph enthusiasts, whether for operating a standard machine, of which there are 40 or 50 different makes and more on the market just now, or building one of their own.

The average pressure exerted on the stylus needle of the best commercially built phonographs today, such as the Victor and Columbia, is about $4\frac{1}{4}$ ounces; as these companies have spent a "King's ransom" in perfecting the phonograph to its present stage, we can rest assured that with standard records, this is the optimum pressure and one which should not be exceeded, except by a small amount in certain cases, perhaps.

Where an extra large sound-box is used with a large diaphragm, say, one having a diameter of $2\frac{3}{4}$ inches, as is the case with several commercial machines, the excessive weight exerted on the stylus and on the record may be counterbalanced with a coun-

ter-weight or else by a spring fastened to the base of the tone-arm and arranged so as to counteract the pressure, which in one case measured 8 ounces, so that eventually the pressure on the stylus when measured by a postal scale placed under it, measured but $4\frac{1}{2}$ ounces, the average standard pressure.

At Fig. 2 is shown the extreme simplicity of the Columbia tone-arm, which provides the usual two degrees of movement, that is, vertical and horizontal. The moving joints are made to have a very good mechanical fit, and the degree of movement is limited by a set screw threaded thru the outside collar, usually, and the tip of this screw caused to move back and forth in a slot in the smaller end of the arm in each case—all of which is clearly shown at Fig. 2. This diagram also shows the horizontal movement A-B of the tone-arm when the latter is centrally located with respect to the turn-table on the average machine. As will be seen, this movement is not so great as might be imagined, and simplifies the construction of the arm if you are building one yourself.

A standard form of tone-arm which is sold by many of the phonograph houses supplying parts for the building of home-made machines, is shown at Fig. 3. With the Victor and Columbia machines it is not possible to reverse the sound-box or throw it over as in some of the other machines, in order to play *hill-and-dale* records such as the Pathé. However, there has recently been put on the market several attachments, selling as low as one dollar, with a sapphire ball complete, by which Pathé or other *hill-and-dale* records can be played on a Victor or Columbia machine. Several of the machines on the market, including those fitted with the tone-arm of the type shown at Fig. 3, play any style of record. The two positions of the sound-box and needle holder are shown clearly in the figure. When playing *hill-and-dale* records, a round sapphire ball point must be used, and this costs but sixty cents and fits in any standard needle holder.

A sapphire ball possesses the advantage over the pointed steel needle in that it will play as many as 1000 records, without scratching or injuring the record surfaces, as a scientific test of the stylus of this machine has demonstrated. A new steel needle should be used for each record, or one needle used for playing the two sides of the record; and if you should want to be real careful about it, it is best to preserve your record by using a new steel needle for playing each side.

The construction of the tone-arm illustrated at Fig. 3, is evident from the drawings. The diameter of the throat at the base of the tone-arm where it fits over the opening in the wooden shelf, is about $1\frac{3}{4}$ inches on the average, and from this diameter it slowly tapers or decreases downward to the point where it enters the sound-box, and here it may have a diameter of about $\frac{1}{2}$ inch to $\frac{5}{8}$ inch. In the Columbia and Victor tone-arms, the arm itself is made of drawn metal, usually brass, and expands progressively from the sound-box to the base of the arm. The trouble with a great many of the cheap tone-arms is that they are made of cast metal, and also their joints are poorly fitted. The greatest criterion whereby to judge the efficiency of any tone-arm, no matter of what make, as pointed out by Prof. D. C. Miller of the Case School of Applied Science, of Cleve-

land, in a recent conversation with the writer, is that it shall be *thoroughly air-tight*, in order that the vibrations set up by the column of air within it shall undulate, swell and amplify as they progress down into the sound chamber in a faithful and natural manner. This cannot be the case, when there are bad *air leaks*, due to poor joints along the length of the tone-arm at any point, and on certain notes, harmonics may make their presence severely noticeable, or, in other words, some of the notes will be harsh or perhaps "flat", depending upon the position of the leak hole and the record being played.

One of the latest developments in tone-arms are those made entirely of wood, which gives a very faithful and mellow reproduction, especially on musical selections. These are supplied on one of the best commercial machines and are also available from phonograph parts companies. Due to their weight they should be mounted in ball bearings in all cases, at their base, and if necessary be very careful and keep it balanced so as not to exert excessive pressure on the stylus or needle. If you are ingenious, you can make one yourself out of good hard wood such as mahogany or walnut. The method used in one commercial tone-arm for swinging the reproducer over and off the record by means of a tubular valve is clearly shown at Fig. 4. The position of the ball bearing ring at the base of the pivot tone-arm, when used, is also indicated.

Construction of Sound Modulators

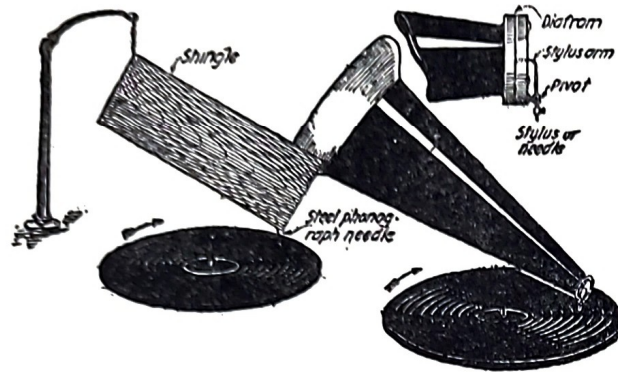
Three distinct and more or less efficacious types of *sound modulators* or *muffers* are shown at Fig. 5, A, B and C. The one shown at A is used on several machines, including the Conried phonograph. It is simply a sliding valve affair, the valve being made of a piece of wood with a circular hole cut thru it. Sliding this hole into register with the tone-arm and sound amplifier chamber gives a maximum sound, while if this valve is moved to the right, the opening becomes smaller and smaller until the sound is a minimum. Movement of the valve is transmitted thru a small metal rod with a button on it, extending thru to the outside of the cabinet.

The arrangement shown at "B" is used on one of the well-known commercial machines, and those desiring to have a flexibly controlled cord, three to four feet long, extending from the side of the phonograph cabinet so that they just push the button on the end of the cable and modulate the tone, can utilize this or a similar principle. A flexible shaft explains the way this trick is worked, the inner end of the shaft moving the wooden or felt covered conical plunger or valve up and down in the throat of the amplifying chamber; when this valve is all the way up, it blocks off the chamber completely. This style of valve has the advantage that it reduces the area of the sound chamber evenly in any position and not unsymmetrically or all on one side as is the case at A.

The efficacy of the valve or modulator shown at C is approximately like "B," which is used on one of the best makes of talking machines. This modulator comprises a metal base-piece, as shown and to which is riveted or secured a piece of thick felt about $\frac{1}{4}$ inch in thickness and extending about

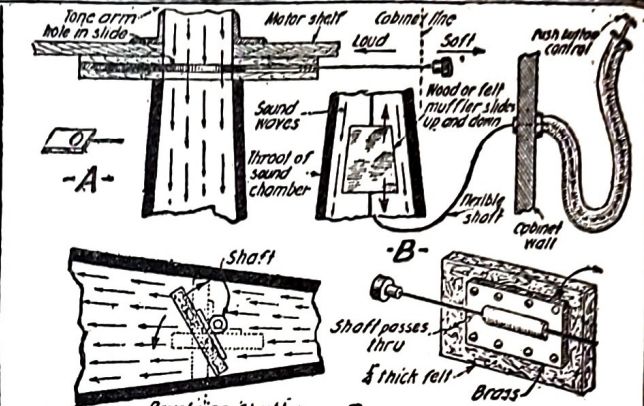
(Continued on page 28)

HOW TO MAKE "YOUR OWN" PHONOGRAPH



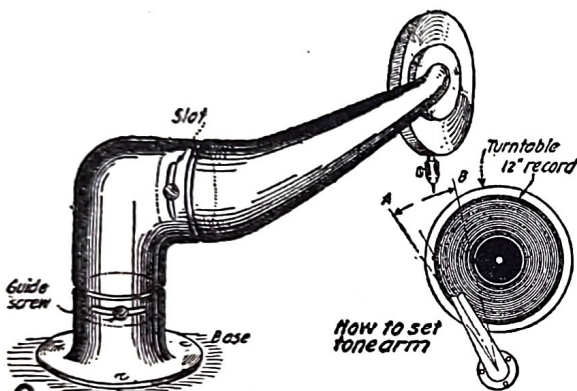
1-

SIMPLE REPRODUCERS



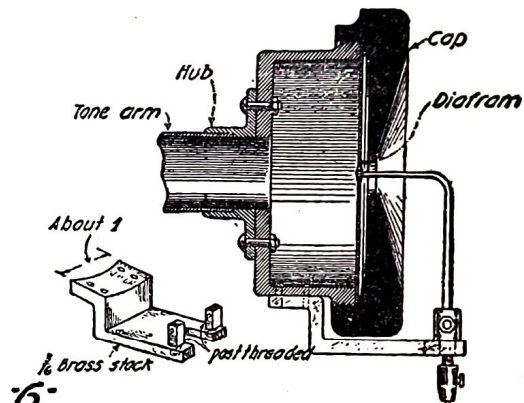
5-

THREE TYPE OF SOUND MODULATORS



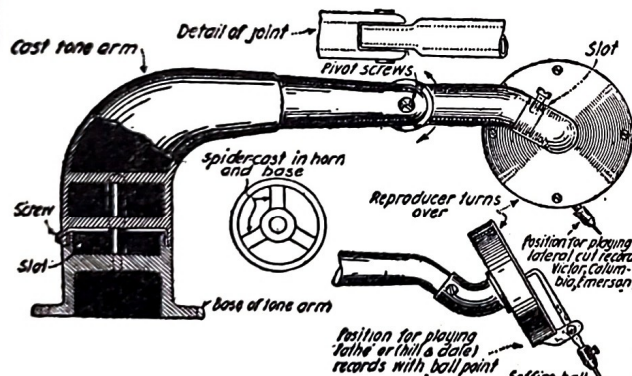
2-

HOW THE COLUMBIA TONE ARM WORKS



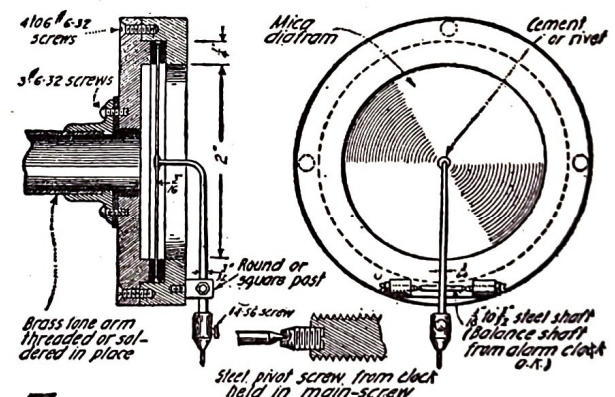
6-

REPRODUCER MADE FROM TELEPHONE RECEIVER



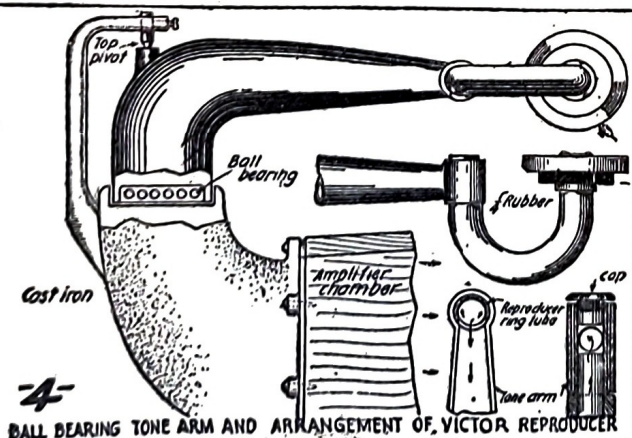
3-

STANDARD TONE ARM FOR PLAYING ALL RECORDS



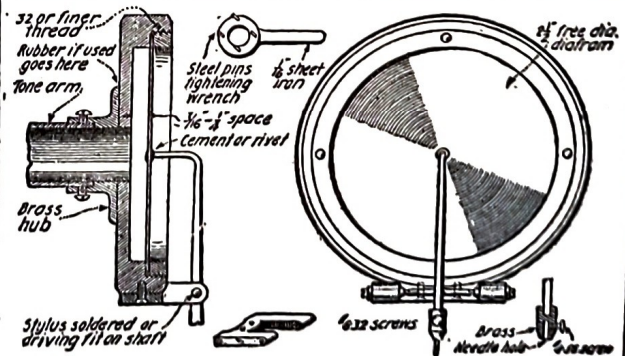
7-

STANDARD METAL TYPE OF REPRODUCER



4-

BALL BEARING TONE ARM AND ARRANGEMENT OF VICTOR REPRODUCER



8-

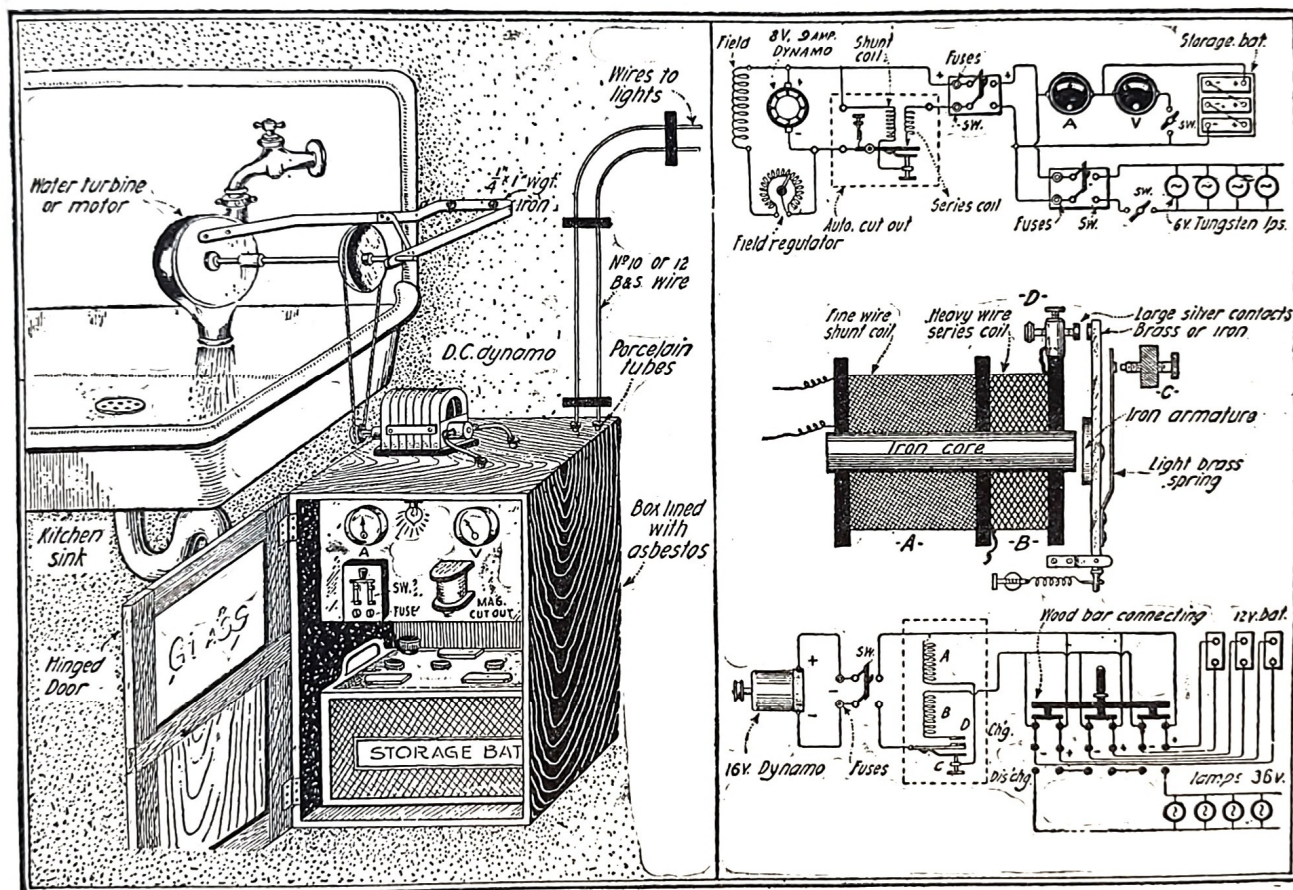
BEST TYPE OF CLAMPING DIAPHRAGM

Electric Power from a Spigot

A SHORT time ago we published an article on a new French invention, whereby a clever Parisian engineer lighted the electric lights in his home by means of a small water motor fastened to a charging dynamo connected with a storage battery, the water motor being operated by the water taken from the spigot every time the latter was opened. We have been flooded with inquiries from many of our readers, asking about the details of such a scheme and while we have not faith in the general adoption of this idea, for the reason that the water pressure would have to be increased in any given locality as soon as a number of people began to use this

order to realize the efficiency pointed out by the French engineer, endeavor to utilize for developing electric power the waste water as it passes from the spigot into the sink, we should, therefore, do all our cooking and washing with the water coming from the turbine or water motor, as shown in the accompanying illustration. It will be seen, therefore, that there are more sides to this story than one, and that if 1,000 people for example, in a town of 5,000, all started to use these spigot electric lighting plants at one time, in order to rotate the water turbines at the desired speed the water pressure would have to be increased in the water mains, owing to the great resistance encountered at

out or circuit-breaker, fused switches as well as storage battery and lamps. This outfit, if employed in connection with a small D. C. dynamo or else a telephone magneto fitted with a commutator and brushes, developing 8 to 10 volts and 8 to 9 amperes or requiring about 1-5 HP to run at full capacity, will successfully charge a 6 volt, 60 ampere-hour lead-plate storage battery. This three cell battery, the standard discharge time for which is eight hours, will take care of 6 to 7, 6 watt or 6 C. P. tungsten lamps for eight to nine hours. The dynamo, to run continuously, will have to charge the 6 volt, 60 A. H. battery at about a 7 1-2 ampere rate for eight hours, to give it



Details of a "Spigot-Electric" generating and storage battery plant are presented in the drawing above and in the accompanying text. It would be possible to rig up several of these on different spigots, each dynamo charging either a "common" battery, or else a battery of its own.

system, we present below a few electrical details which may be of interest to the experimenter, who may like to try out this arrangement.

Before going further it may be best to describe the action of a water motor, and particularly a large number of them, when connected to a central water distributing system in a city or township. When a load is put on to the water motor such as by belting a dynamo to it or otherwise, the speed of the motor will be reduced, and this is just where the reaction on the water system begins to take effect, for the water will no longer flow out thru the discharge of the water motor as freely as it did before the load was put on. In other words, the more load or the more electricity produced and "fed into the storage battery," the slower the water motor will turn in proportion, and thus a smaller quantity of water will pass thru the water motor. Now as we must, in

the various water outlets to which the dynamo turbines had been attached.

In other words to overcome the extra effort required by the water in endeavoring to pass thru the turbines and rotate them with their load at the same time. So if the water company had to do this in order to enable their customers to procure electric lights for their homes in this fashion, they would not get the lights for nothing, as so many have apparently imagined, but the water company would charge a considerably higher rate for the water service, owing to the fact that they had to raise the pressure in order to operate your plant as well as your neighbors' electric plants.

For those interested in this subject, however, in an experimental way, the accompanying diagrams will undoubtedly prove of interest. Fig. 1 shows a complete wiring diagram or circuit for the direct current charging dynamo, automatic charging cut-

a full charge. It would have to charge the battery much longer, of course, if the dynamo operated only at intervals, as when water happened to be drawn from the spigot. If the dynamo could be operated sufficiently steadily to charge two 6 volt, 60 A. H. storage batteries, these when fully charged would take care of 12 to 14 6-watt lamps for eight to nine hours; or if the battery should be left connected to the dynamo, thru the automatic cut-out of course, while the lights were being operated, then the lamp load would be shared between the dynamo and the battery.

A few words about the charging dynamo and the installation of the batteries. The dynamo must always develop a voltage of about 10 per cent higher than the counter E. M. F. from the battery at any moment, in order to force electric energy into it, or otherwise the battery will discharge back

thru the dynamo (providing no automatic cut-out were used).

Most people are not interested in 6 watt, 6 C. P. tungsten lamps, but use at least a 40 watt tungsten lamp, giving approximately 40 C. P. For the benefit of the average householder who is interested in this idea of providing electric lights from the spigot, data is given below on a more pretentious outfit operating at 36 volts. This potential is commonly used in connection with isolated farm lighting plants today, and standard lamps and other apparatus is available for this potential. It will be seen after looking over these paragraphs that it will take a pretty husky turbine and a considerable amount of water pressure (the small water turbines require at least 60 pounds pressure to show anything like efficient results, and they really need 80 to 100 pounds pressure to do good work) and for driving a 40 volt D. C. generator capable of delivering 12 1-2 amperes or about 500 watts for charging a 36 volt, 100 ampere-hour storage battery, will require about 3-4 H. P., at least, at the turbine shaft. This calculation is based on the fact that the battery is recharged at the usual rate, requiring eight hours, that the potential increases from 36 to 40 volts, as the battery counter E. M. F. increases, all this with an average charging current of 12 1-2 amperes. Of course, if the lights were not used very often each day, it would be possible to keep a small charge trickling into the battery every now and then, by means of a lower wattage dynamo wound to give 36 to 40 volts, but only a fraction of the current in amperes stated above, or say 2 to 3 amperes.

For those interested, a diagram is given at Fig. 2, showing how an automatic charging cut-out is constructed, and at Fig. 3 a special wiring diagram is presented which was designed to permit charging three 12 volt 100 A. H. storage batteries on parallel from a 16 volt dynamo and then by simply throwing over the switch would enable the batteries to discharge in series, so as to provide 36 volts, average potential. This figures out, as will be seen all the way thru, at about 2 volts per cell mean potential, but the rate varies during discharge, being about 2.2 volts at the start and dropping to about 1.8 volts at the end of the discharge. If the three 12 volt 100 A. H. storage batteries were fully charged, they would be capable of lighting 10 40 watt, 40 C. P. 36 volt tungsten lamps at one time, for a period of about eight hours. This has been figured out for the standard or best rate for lead storage batteries, which is taken as eight hours.

The special series-parallel charge and discharge switch shown at Fig. 3 can be constructed from three double-pole double-throw switches mounted together and with the handles of the three switches firmly joined by a single bar, provided with a single handle if desired. The switch can then be thrown as one switch.

The positive pole of the dynamo must always come to the positive pole of the storage battery and this must be watched very carefully. Regarding the automatic cut-out or circuit breaker, this can be purchased from small electric lighting plant supply houses or manufacturers or else can be built by the experimenter himself. The action of this is as follows: For 10 or 15

volt potentials the shunt or high resistance, fine wire coil may have a value of 100 ohms or more; for small charging systems, such as 75 watt outfits, such a charging relay can be built from a discarded bell or buzzer, re-winding it to suit. The series coil on the cut-out is wound with No. 12 insulated magnet wire for 10 to 15 ampere currents, while the fine wire coil can be wound with about No. 28 insulated magnet wire. Now when the dynamo speeds up sufficiently to produce a higher voltage than that given by the battery, the pull on the armature of the cut-out is varied, until it will just close, in this case opening the shunt coil circuit. With the charging voltage right, i.e., higher than that of the battery, the armature when it closes, makes contact with the series coil terminal and the charging current from the dynamo passes thru the armature and into the battery, as becomes perfectly clear from Fig. 1.

If at any moment the charging dynamo should drop in speed and consequently in voltage, the counter E. M. F. produces a reverse current from the battery, passing thru the series coil now holding the relay armature down, creating a reverse magnetic polarity in the iron core, which will cause the armature to be released. This does two things, it puts the circuit breaker in condition to close the circuit again, as soon as the voltage and speed of the charging dynamo have accelerated to the proper value, and most important of all, it has prevented the storage battery from discharging back thru the dynamo, which will be liable to demagnetize or burn it out, besides running down the storage battery and possibly sulfating and buckling it.

Building Your Own Phonograph

(Continued from page 25)

$\frac{3}{8}$ to $\frac{1}{2}$ inch from the metal all around. The shaft on which this valve is mounted, passes thru two tightly fitted brass bushings or bearings, secured in the two side walls of the throat of the amplifying chamber. The action of this modulator is evident,—the tonal strength being a minimum when the valve is in the vertical position, blocking off the chamber completely, and at a maximum when it is turned to the horizontal position.

Sound-Box Details

For those endeavoring to build a talking machine as cheaply as possible, a good sound-box costs quite a considerable amount, and if you have a lathe or machine shop facilities you can build a first class sound-box yourself, or have the necessary parts machined up by a machinist at a nominal cost.

One of the simplest sound-box designs we can make, can be constructed from a watch-case telephone receiver as shown at Fig. 6. A metal hub forms one of the best ways of joining the receiver, whether it be metal or hard rubber composition, to the tone-arm tube. The diaphragm, either of mica, fiber—yes and tin has been used on some cheap machines—is clamped securely by the usual screw cap. Making a new cap of metal and threading it to fit the threads on a metal shell, will permit you to tighten it up so as to hold very firmly the diaphragm; this is one of the all-important things in phonograph sound-boxes if you want it to be free from rattling and other unwanted noises when certain notes or chords are played, which noises often are the symptoms of a loose diaphragm, even on the best machines.

The support carrying the upright post for the pivot screws, which may be ordi-

nary binding posts, is readily bent by heating the brass, or iron stock, it is to be formed of. The stylus arm can be cut from sheet brass or other material and cemented or riveted to the exact center of the diaphragm. The needle holder or chuck may be fashioned from a small binding post, but this is best made, of course, of the shape shown in the drawing.

Before going further, it may be said that the average diameter, that is, the free vibrating diameter of the diaphragm, in the average phonograph sound-box measures two inches, some a little less, while others are appreciably greater. The greater the diameter, the lower the pitch of the machine, while the smaller the diameter, the higher the pitch. A mica diaphragm usually measures about 6 mils or six-thousandths inch in thickness and is held between rubber gaskets as shown at Fig. 7. The sound-box design as shown at Fig. 7, is one used a great deal among competition tone-arms, and as will be seen, it is very simple to make from brass or other metal,—the diaphragm being clamped between rubber gaskets, which may be formed of the two pieces of rubber tubing cut so as to exactly meet, end to end. The stylus pivot shaft can be the tempered steel shaft from a discarded alarm clock balance-wheel. With a little ingenuity, the tempered steel pivot cup-screws can also be used, by mounting them in larger screws which pass thru the stylus bearing posts as shown in the diagram.

The upper end of the stylus arm is in some cases, both riveted and cemented to the diaphragm. Suitable cement such as that used for repairing china, etc., can be obtained from any drug store. Red sealing wax is excellent, too.

An excellent stylus and sound-box is illustrated at Fig. 8, and in the writer's opinion it is one of the most desirable. Here

the diaphragm clamping ring is simply a circular brass ring threaded on its periphery to fit the threads which have been turned on the inside of the reproducer shell, and the finer the threads the better, as the pressure can be applied more firmly and evenly. To tighten up the ring or to release it, use is made in this case, of a special wrench to be made for the purpose. It is fitted with from two to four steel pins, depending upon how many holes are used in the ring. In the average phonograph sound-box, the distance between the diaphragm and the surface of the inner wall is about $\frac{1}{4}$ inch. Any sound-box made like that at Fig. 8, with a diaphragm having a free vibrating diameter of about $2\frac{1}{4}$ inches, gives excellent results and corresponds in size to the one now in use on the writer's phonograph.

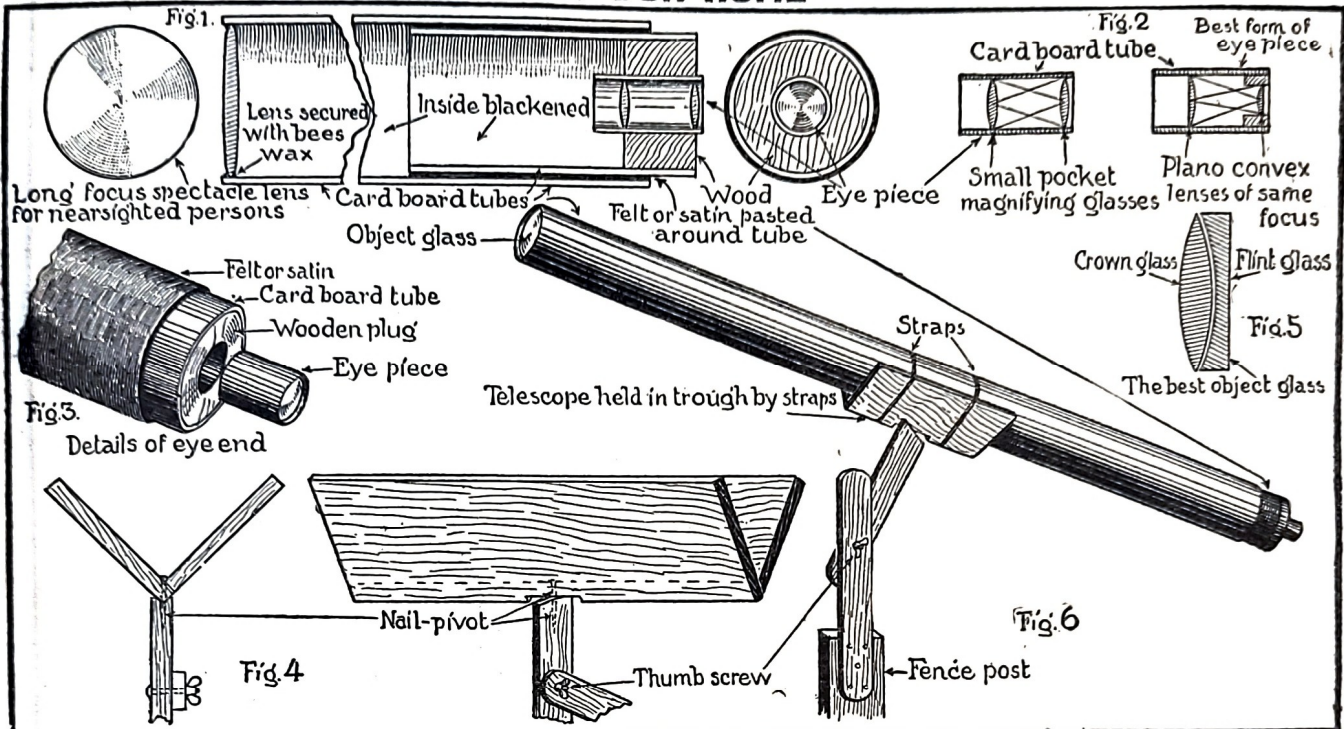
Rubber gaskets, not shown around the diaphragm at Fig. 8, are invariably to be used to absorb extraneous vibrations.

Among the substances which have been used are fiber, silk tightly stretched, gold-beaters' skin, Bristol-paper, tin, and particularly German silver which gives very good results indeed.

A friend of the writer's recently obtained a patent on a novel improvement in sound-boxes which enables any machine to be adjusted as to pitch for different ranges of sound, thus adapting any given diameter diaphragm to low, medium or high pitch records. Briefly explained, it comprises an adjustable ring fitted over the diaphragm and reducing its free vibrating diameter; the smaller the diameter, the higher the pitch, such as for playing soprano or tenor selections; while the larger the diameter permitted, the lower the pitch, such as for playing baritone or bass selections. Finally, if you want the sweetest music, try fiber needles, or cactus points,

An Inexpensive Telescope

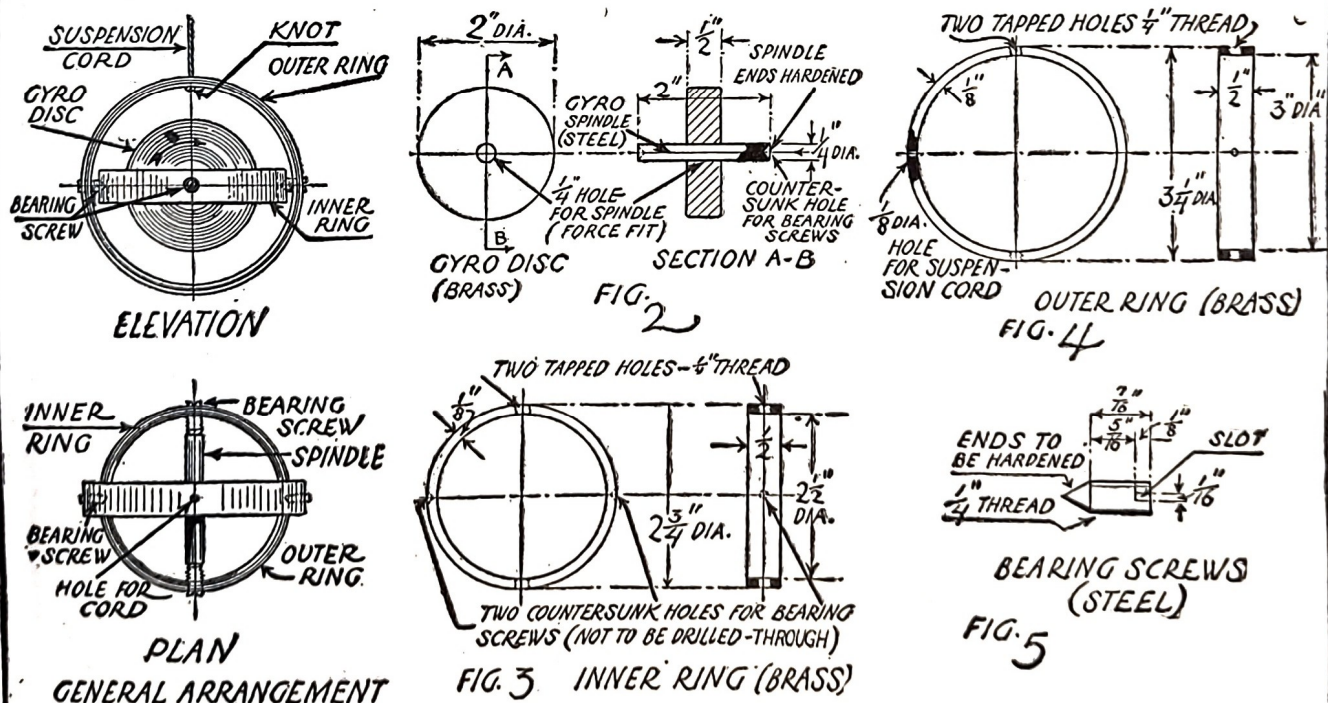
An Instrument which May be Made with Ordinary Lenses
By DON HOME



With the aid of a spectacle lens, a cardboard mailing tube, and a couple of pocket magnifiers, it is possible to make a telescope that will really work. The lens should be such as is employed to correct far-sighted vision and should have a focal length of thirty to forty inches. The outer tube should be slightly shorter than this figure. With this simple telescope the craters on the moon can be distinctly seen. With a dark glass, sun-spots will be

visible and certain stars, single to the naked eye, will appear as double. In order to entirely free the images from color aberration and distortion it is necessary to use the improved eye-piece and object glass. With different sizes of magnifying glasses, it is possible to make several eye-pieces that will give different magnifying powers. The finished instrument can be readily mounted as shown in Figs. 4 and 6.

A Gyroscopic Plumb Bob

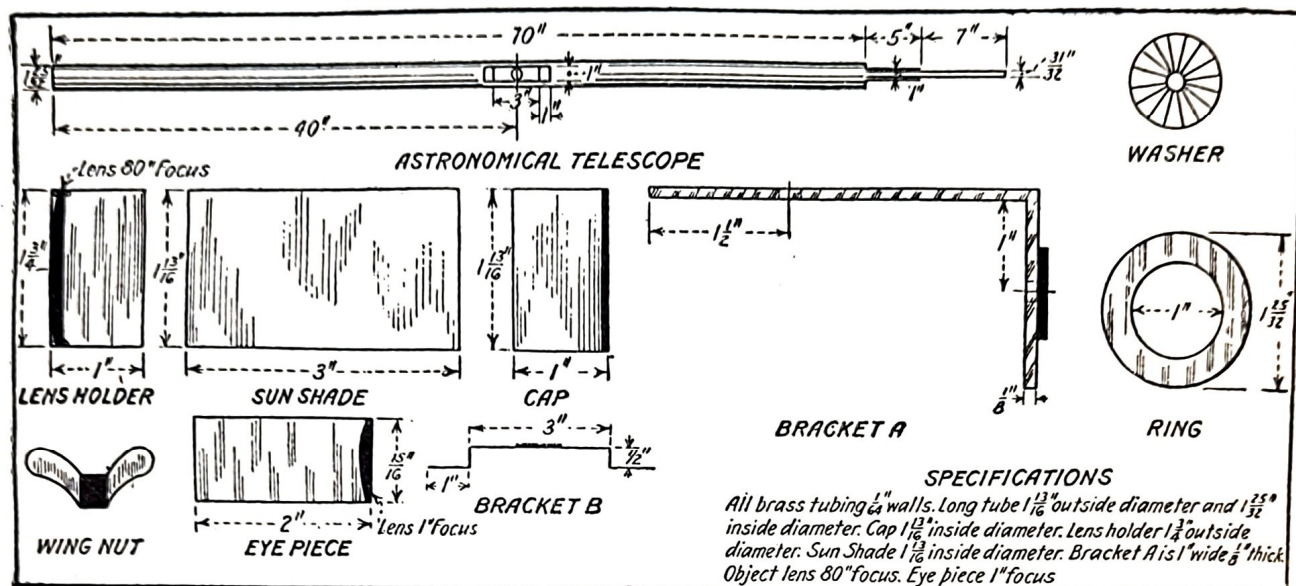


A gyroscopic plumb bob is of great assistance when accurate lining up has to be done where a light breeze is present or vibrations are caused by machinery which would cause an ordinary plumb bob to swing. The diagrams above show how a plumb bob may be made which will do away with these annoyances. The elevation and plan views of the finished gyroscope are shown. Fig. 2 shows the gyroscope disc cut from a brass bar 2 inches

in diameter. The spindle is made of hardened steel. Fig. 3 gives the dimensions of the inner ring and Fig. 4 those of the outer ring. The shape and the dimensions of the bearing screws are given in Fig. 5. After the instrument is made and assembled as shown, the suspension cord is placed in position and a short, strong cord is wound around the spindle. Draw cord off quickly and disc will rotate.

—C. A. Oldroyd.

A Home-Made Telescope



The illustration above shows how to build a telescope capable of magnifying eighty times. With it the mountains on the moon can be distinctly seen when the moon is in the first or third quarter. Jupiter's moons and Saturn's rings are also visible, and many other objects in the sky are clearly discernible. The main telescope tube measures 70 inches in length. The telescope may be mounted on a camera tripod, or on a home-made one specially devised for it.

MANY fellows want a telescope, but the purchase price is generally prohibitive. I decided to make one, and succeeded in doing so at a cost of less than \$4.00. It has more than paid for itself in the pleasure I have received.

The telescope magnifies 80 times. The mountains on the moon are distinctly seen when the moon is in the first or third quarter. Jupiter's moons and Saturn's rings are also visible, and many other objects in the sky are clearly discernible.

The main tube is 70 inches long and $1\frac{25}{32}$ inches inside diameter. In one end of this a brass ring is inserted, which has a hole 1 inch in diameter. This is to hold the 5 inch tube which is soldered to the ring. The ring is then soldered to the long tube. A 12-inch piece of tubing $1\frac{13}{16}$ inches outside diameter should slide easily in the 5-inch tube. In this manner the telescope is focused. The eye piece is a small hand magnifier, having a 1-inch focus. It comes in a small tube 2 inches long and $1\frac{5}{16}$ inches outside diameter. This fits easily in the 12-inch focusing tube.

The object lens holder is made from a piece of tubing $1\frac{1}{4}$ inches outside diameter

and 1 inch long. This fits in the long tube $\frac{7}{8}$ of an inch, it being stopped only by a small pin inserted and soldered to the long tube. A small piece of the holder should be left sticking out of the long tube so it may be grasped and withdrawn for cleaning the lens. To keep the lens from falling out, a small copper wire is soldered around one end of the holder near the edge, care being taken to see that a smooth seat is made for the lens. The holder is sent to an optician to have him fit an 80-inch focus plano-convex lens to it. The lens is held in place by a brass spring coiled once around the inside of the holder. The spring wire should be about the same size as the copper wire seat holding the lens.

A cap is made from a piece of tubing $1\frac{13}{16}$ inches inside diameter and 1 inch long. A piece of sheet brass is soldered to one end of the tube, closing that end. This cap protects the lens when not in use.

The telescope is now assembled, and balanced on one finger to find the center of gravity. A bracket is made from a piece of sheet brass 6 inches long, 1 inch wide, and $\frac{1}{16}$ inch thick. This piece is

bent at right angles 1 inch from the end. It is again bent in the opposite direction $\frac{1}{2}$ inch up from the first bend. This completes one side, and the other side is made in the same manner. This is now drilled in the center to hold a machine screw. A brass washer that has been sawed on one side to make it rough is soldered smooth-side to the bracket. The machine screw is now inserted. The bracket is then soldered to the telescope at the center of gravity.

The mounting for the telescope is a large camera tripod. A piece of brass 6 inches long, 1 inch wide, and $\frac{1}{8}$ inch thick is bent at right angles 2 inches from one end. A hole is drilled 1 inch from the short end and $1\frac{1}{2}$ inches from the long end. A brass washer like the one mentioned above is soldered to the short end on the outside. This bracket is screwed on the tripod where the camera usually sits. The telescope is screwed on the bracket and tightened up with a wing nut. With this arrangement the telescope may be swung in any direction and set at any point. The telescope is sandpapered with the finest sandpaper and lacquered.

Contributed by H. A. T.

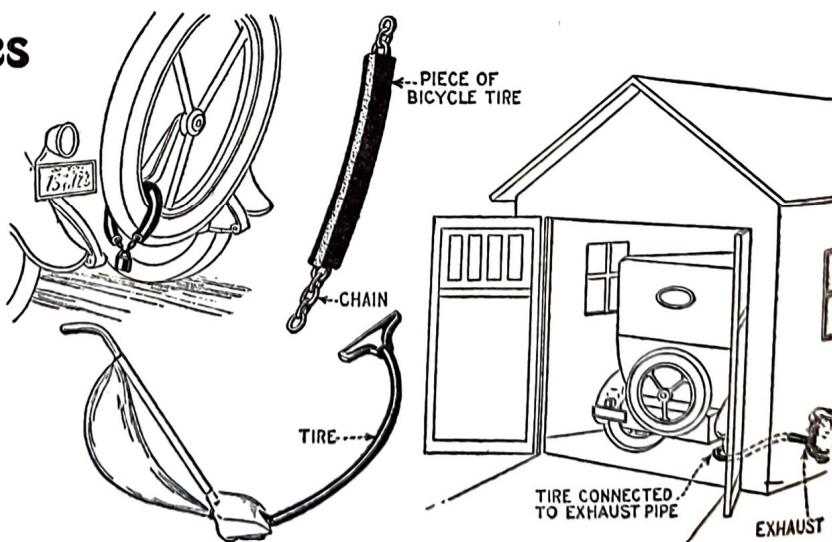
Uses for Bicycle Tires

OLD bicycle tires that have been discarded as being worthless for their original purpose can be put to many other uses and will be found most satisfactory. The illustration at the right suggests three different ways in which tires of this nature can be employed. The first is as a protection around a chain used for locking the spare tire of an automobile. Under ordinary conditions, a bare chain is very apt to chip or scratch the paint on the car. If, however, a section of bicycle tire is slipped over the chain and used as shown, no damage can be done.

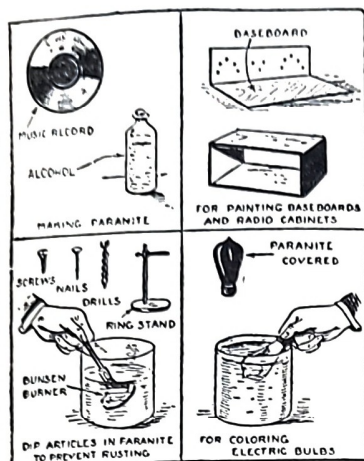
A piece of tire that does not have too many air leaks in it can be put to use on the vacuum cleaner and used as an extension hose so that the nozzle can reach out of the way places.

Running the engine of a car in a closed garage is often the cause of death, due to the carbon monoxide liberated from the engine exhaust; this gas can be piped to the outer air by means of an old bicycle tire slipped over the exhaust pipe and projecting through a hole in the wall.

—H. E. Wenrich.



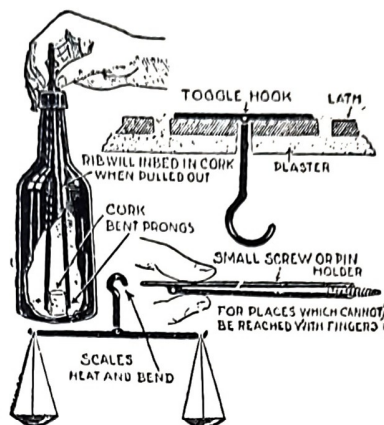
Useful Solution



Paranite consists chiefly of shellac, lamp black and rotten stone dissolved and partly suspended in alcohol. It is useful for painting baseboards, preventing rust and may be made from old phonograph records.

—Wm. M. Goldberg, Rep. No. 516.

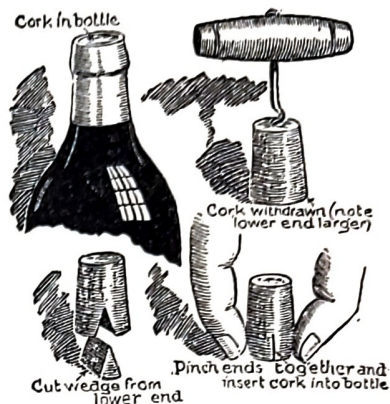
Uses for Umbrella Ribs



Umbrella ribs can be used for a variety of purposes. For instance, if the prongs are bent inwardly, they make an excellent cork extractor. They are admirable for holding screws and make good scales.

—W. T. Markowski.

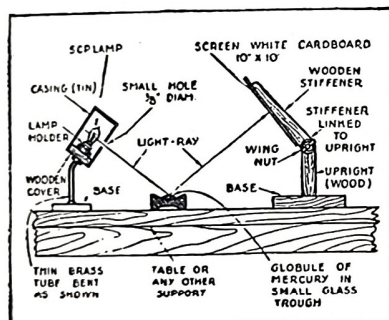
Simple Cork Wrinkle



Often one will find that the corks on being extracted from bottles are larger at the bottom than at the top, and are difficult to force into the bottle again. If a small wedge is cut out of the lower end, the process of reinserting the cork is greatly simplified.

—N. O. Edema.

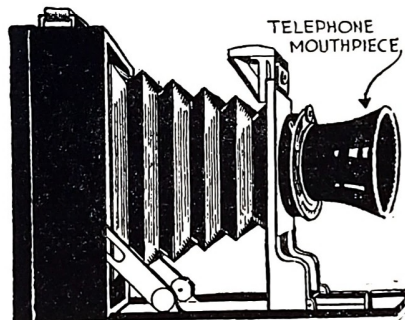
Tracing Vibration



Mercury placed in a shallow container such as is used by water color painters, and the apparatus shown above will enable one to determine the amount of vibration in a room or in machinery. The light spot dances on the screen, and may be photographed.

—C. A. Oldroyd.

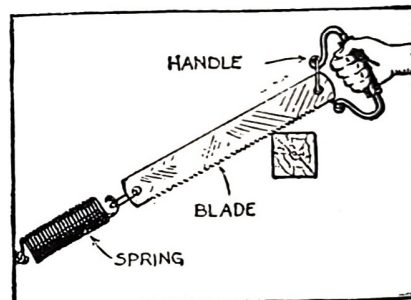
Handy Lens Hood



Oblique rays of light often fog the picture by striking the lens. To overcome this, a lens hood may be made by cutting off the threaded portion of a telephone mouthpiece, and enlarging the hole to make a tight fit over the lens tube.

—Dr. Hugh Winfrey.

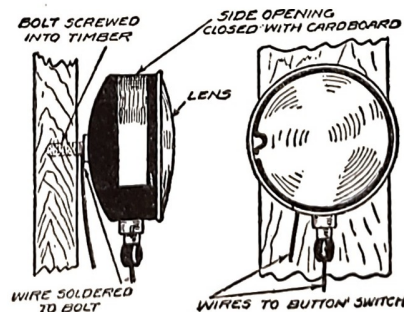
Handy Hack Saw



By fastening a curtain spring to one end of a hacksaw blade and a handle similar to those put on packages, a serviceable saw is obtained. The same system can be employed in using a scroll saw.

—N. Webster, Jr., Rep. No. 7165.

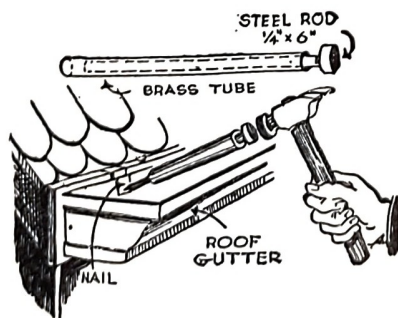
Photographer's Ruby Light



Removing the nut from the back of an old tail light, and screwing the light to a support, then covering the side opening with cardboard, and connecting the wires to the battery, a ruby lamp is made.

—L. B. Robbins.

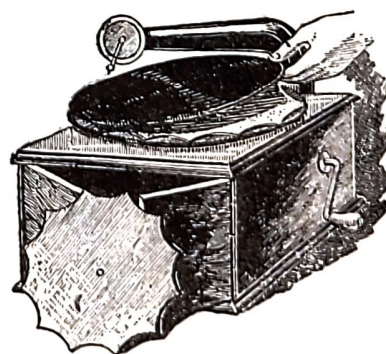
Nail Extension



Where it is almost impossible to drive a nail with a hammer, the nail extension shown is very handy. The steel rod may be magnetized for holding the nails.

—L. A. Parker.

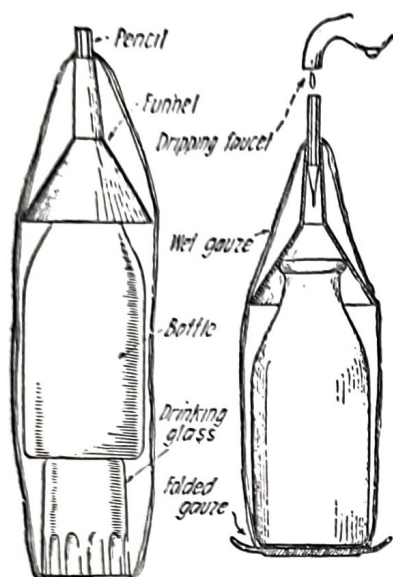
Removing Records Easily



A serrated disk of blotting paper is glued to the turntable of a phonograph. The serrations are cut to a depth of one inch, and provide spaces beneath the edge of the record to allow for insertion of the finger nail.

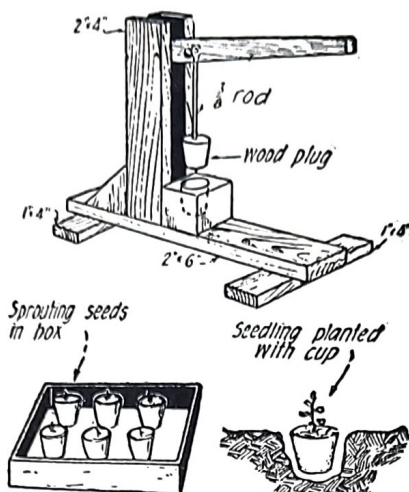
—G. E. Hendrickson.

Cooler



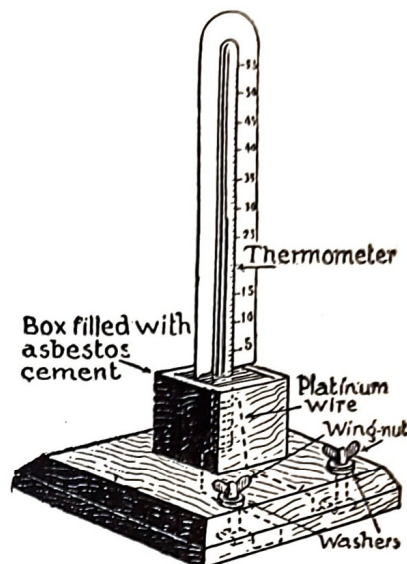
By placing a funnel over a bottle to be cooled, setting the bottle on a tumbler, tying the arrangement together with gauze and allowing water from an ordinary cold water faucet to drip slowly over it, as shown, evaporation will keep the contents of the bottle quite cold. —J. M. Kendall.

Plant Cups



For the early spring gardener the above kink will be found exceptionally useful. Such plants as tomatoes and cabbages which have to be reset, are often retarded in their growth by such resetting. If cups are made of ordinary newspaper print paper with the aid of the form illustrated above, and the seeds of the plant sprouted in the cups, the gardener will be well repaid for his work in constructing the form by the advanced growth of the plant. The block and the plug used to form the cups may be made in any dimensions desirable. Two or three different sized blocks may be used in the same press. —Dale R. Van Horn.

Ammeter



A novel comparative ammeter is illustrated above. It consists of nothing more than a thermometer around whose bulb have been wound a few turns of resistance wire. The bulb and wire are then embedded in a small square container which is filled with asbestos cement. The rise in the thermometer will be directly proportional to the current passed through the resistance. —Simon Cherry.

Microtone

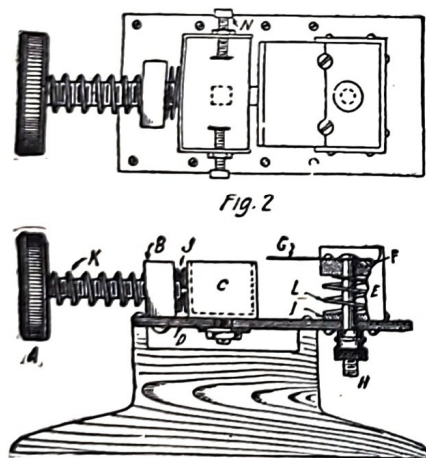


Fig. 2

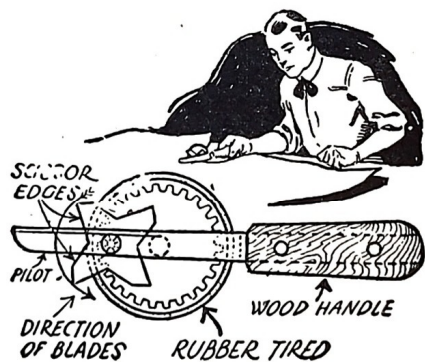
Fig. 1



Fig. 3

Many experimenters using a microscope will at once see the value of the microtone shown above for slicing specimens. The thickness of the cut is regulated by nut H, which adjusts the height of the safety razor blade G. Specimen is imbedded in wax and held in the cup C.—E. H. Swanson.

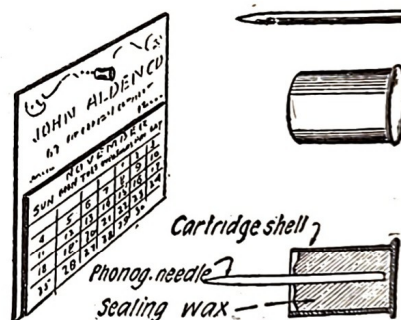
Scissors



GEARED, RUBBER TIERED DRIVE WHEEL
SMALL GEAR SOLID WITH BLADES
-CAPPED AXLE BEARING IN ONE SIDE OF ONE PIECE FRAME

From those who do a great deal of cutting, the mechanical scissors illustrated above, will find a happy reception. The rotating blades are geared to the large wheel which has a rubber tire and is fixed to the handle of the machine which is made of an old scissor's blade. As the wheel runs along the counter or table, the blades revolve cutting the heaviest cloth. The fixed blade acts as a guide, feeding the cloth to the rotating blades. —Thomas H. Duffy.

Cheap Push Pin



By imbedding a phonograph needle in sealing wax in a small cartridge shell, as illustrated above, a very efficient and very cheap push pin results. —Lewis M. Baldwin.

Artificial Cigar

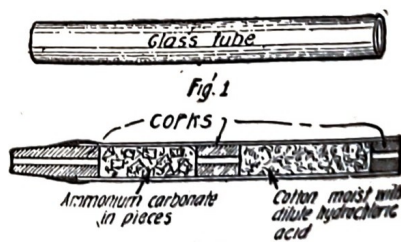
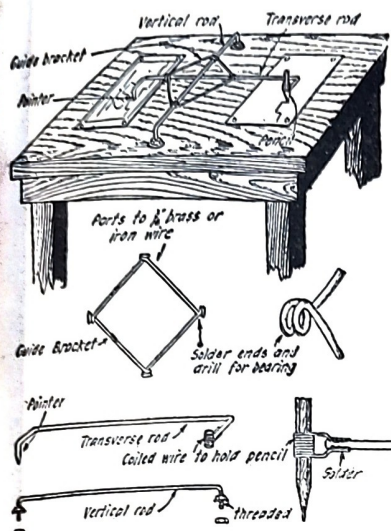


Fig. 2

By covering a glass tube with cigar wrapper and using corks and chemicals as shown, a harmless artificial cigar is made. —S. Marchese.

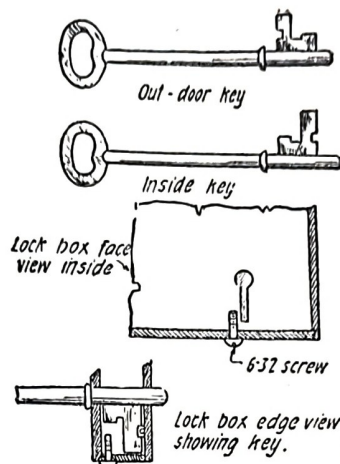
HOW TO MAKE IT Drawing Tracer



With the use of a lateral guide wire and the sliding arrangement shown in the above sketch a drawing may be traced from one sheet to another very easily.

—G. A. Luers.

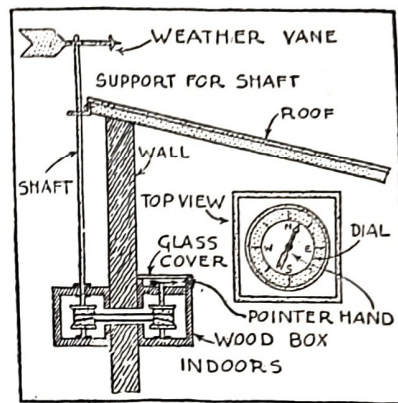
Safety Lock



An ordinary lock may be made pass-key proof by inserting a small screw in the lock box as shown in the above illustration. Two keys will have to be used for this arrangement, one for operating the lock from the outside and the other for use when locking the door from the inside. The keys are notched as shown.

—Jacob Raible.

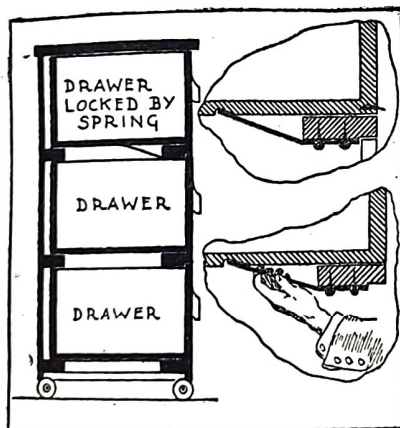
Weather Vane



This mechanical indoor wind direction indicator is composed of a weather vane on a shaft, a pulley with belt extending through the wall of the house, a second pulley with shaft, a pointer and a dial. The parts are assembled in the fashion shown above. The pointer is fastened to the end of the shaft of the second pulley. The movement of the vane at the top of the house is communicated to the indicator by the belt.

—Evermont Fisel.

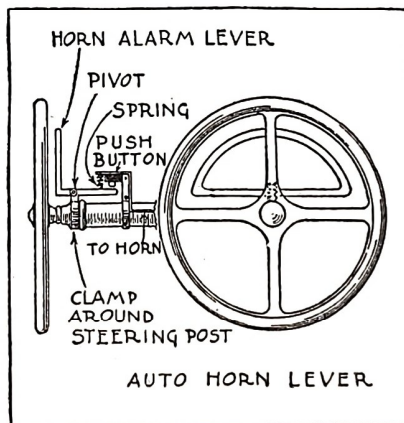
Drawer Lock



For locking one drawer of a chest a good system is to place a spring and notch as shown above. The drawer is unlocked from the one below it.

—E. Joy Betterley.

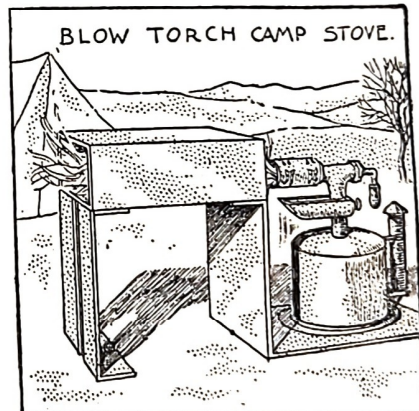
Horn Button Kink



The automobile horn button kink shown above is simply an auxiliary button-pressing lever attached to the steering column in such a way that the horn may always be sounded.

—Geo. Beane, Jr.

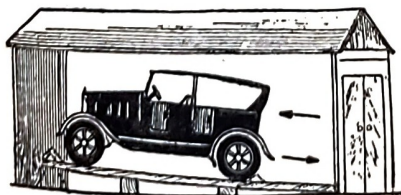
Camp Stove



The camp stove illustrated is made of a large metal oven-like box into which is directed the flame of a blow torch. The metal box may be constructed so as to be collapsible.

—Harold Jackson.

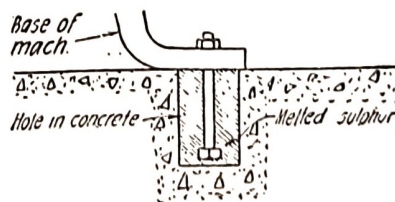
Garage Floor



By tilting the floor of a garage as illustrated above the automobile may be run out by simply releasing the brakes in case of an emergency like fire.

—R. C. Leibe.

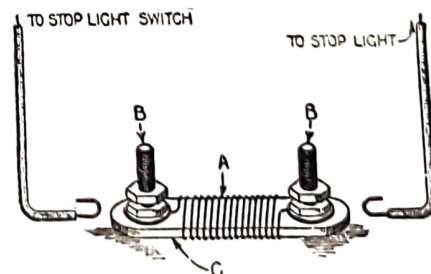
Machine Base



Where concrete floors are laid and a new machine is to be installed upon it, placing the floor bolts in melted sulphur will save much trouble.

—John Krebs, Jr.

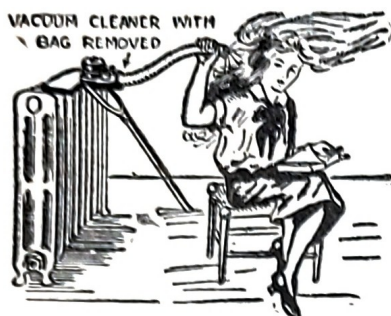
Stop Light Resistance



A few turns of resistance wire wound on an insulator as shown will save many "Stop Lights."

—M. A. Simon.

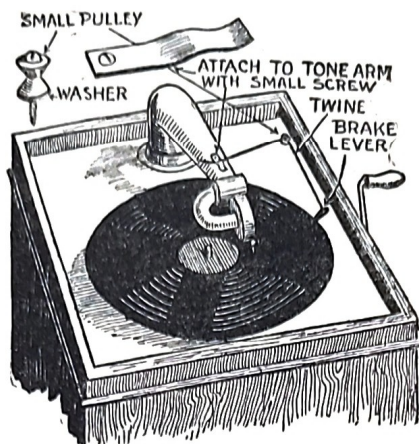
Hair Dryer



By placing a vacuum cleaner atop the radiator as shown above, the hot air pulled through the cleaner and ejected at the exhaust will be found very effective in drying the hair.

—F. L. Kelsey.

Record Stop



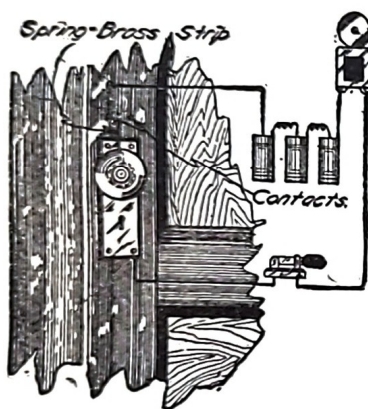
By attaching the small spring clip to the tone arm of a victrola installing a small pulley, and running a thread from the brake lever to the clip, an effective stop is made. —W. T. Markowski.

Fine Writing



By attaching a magnifying glass to a fountain pen, as shown, surprisingly small script can be written by anyone. Try it. —Jacob Schmidt.

Burglar Alarm

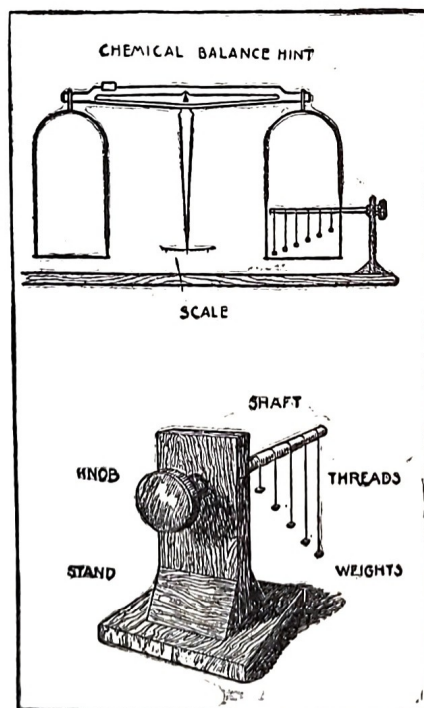


Two nail contacts, a bit of spring brass and some battery wire attached to the door as shown in the above illustration, form an effective burglar alarm.

PRESERVING CHEESE

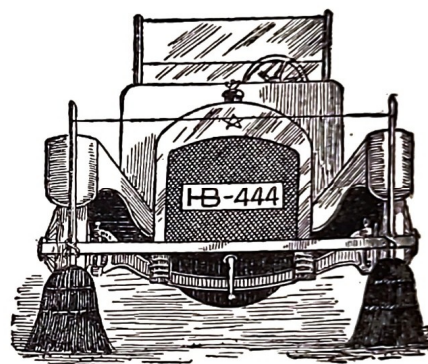
The best method of preserving sliced Swiss cheese is to keep the slices constantly wrapped in a damp sheet of white linen, except during actual eating-time. —C. Nye.

Balance Kink



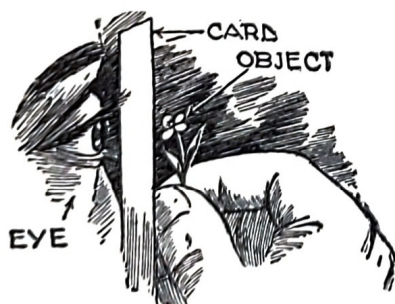
Where much weighing is to be done, the arrangement of attaching the weights by fine silk threads to a shaft and knob which holds them over the balance pan, so that they may be dropped on the pan consecutively, is very good. Very fine thread must be used so that its weight will have no effect on the balance. —Esten Moen.

Save Punctures



If the street sweepers go on strike, try the above idea for preventing punctures. It may come in handy around the garage driveway if there are bits of glass or tacks about. —F. Fornos.

Magnification



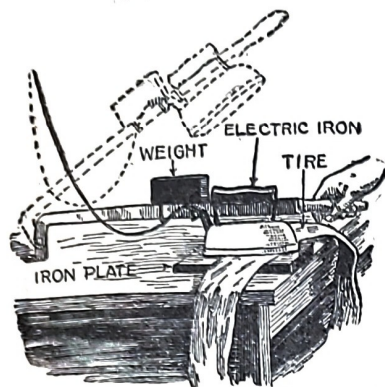
When afield and needing a small magnifying glass, punch a small hole through a bit of cardboard, and observe the image close to the eye. Greater magnification can be had in this manner than with the ordinary small lens. Observation must be made in a very strong light. —Don Home.

Filling Balloons



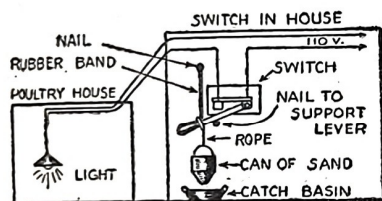
For filling toy balloons with buoyant gas allow the gas to pass into the football bladder, then close the first cock and open the second, and force the gas into the balloon. This system allows sufficient pressure to be placed on the gas to force it into the balloon, which is not possible, using only the pressure of the gas mains. —W. L. Todd.

Vulcanizer



By attaching an electric iron to a weighted arm, as shown above, and fixing an iron plate beneath it, a vulcanizer results. —W. B. Matthews.

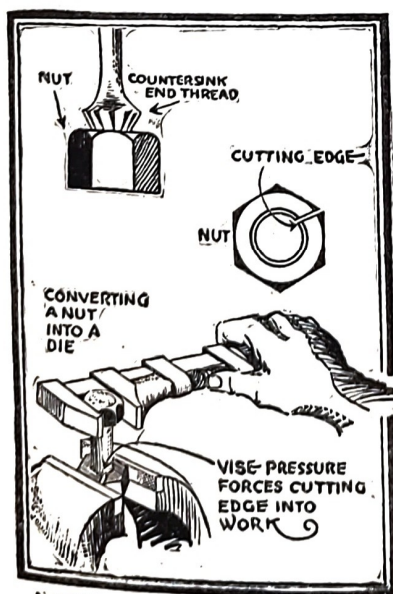
Electric Feeder



The sand drips out of the bucket attached to the switch just at the right time to allow the rubber band to close the switch, lighting the light or actuating a feeder in the poultry house.

—J. Stevenhagen.

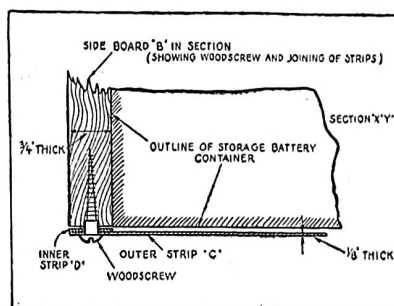
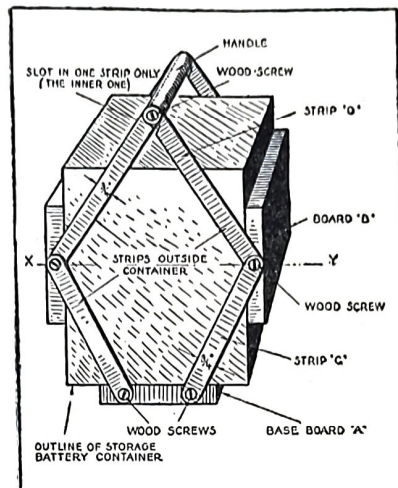
Nut Die



A nut die is made by slotting one side of the nut, counter-sinking it at one end and holding it in a vise, as shown.

—G. A. Luers.

Storage Battery Carrier



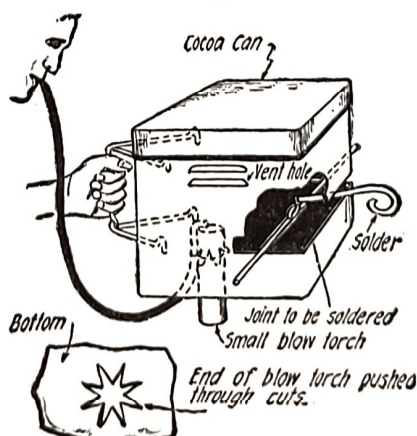
A few pieces of board, some thin iron strips and a piece of broom stick make a carrier for storage batteries.

—C. A. Oldroyd, Reporter No. 4433.

SPIRIT WRITING TRICK

Dissolve 40 parts of saltpeter and 20 parts of gum arabic in 40 parts of warm water. Write or draw pictures on white paper with this solution using a common pen. All the lines must connect, however, and one of them must run to the edge of the paper, where it is to be marked with a pencil. When a burning match is held to the marked spot the line begins to glow, and spreads quickly all over the writing or design, making the formerly invisible design appear signed.

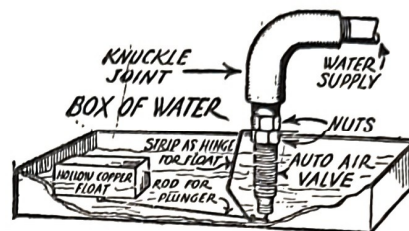
Soldering Kink



The cocoa can with handle and slit inside acts as a shield for doing outdoor soldering work in the wind.

—Paul F. Bryant.

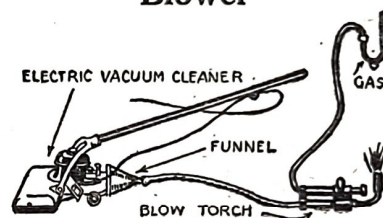
Chicken Font



The water supply for the chicken font is controlled by an ordinary auto tire valve secured to the pipe line. A float made of copper opens the valve when the water supply is low.

—J. Baxter Gardner.

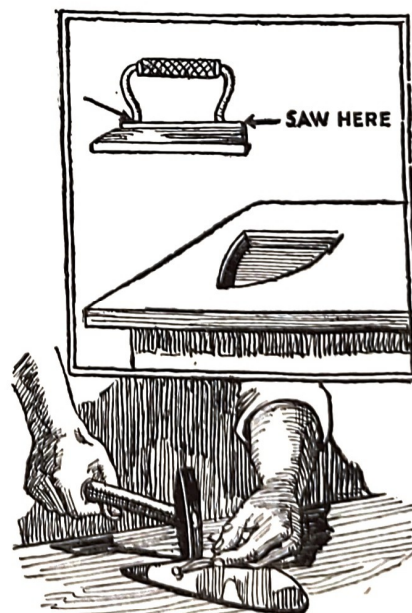
Blower



A blow torch using illuminating gas may be provided with air at pressure by using the back draught of a vacuum cleaner, as shown above.

—Alvin W. Hass.

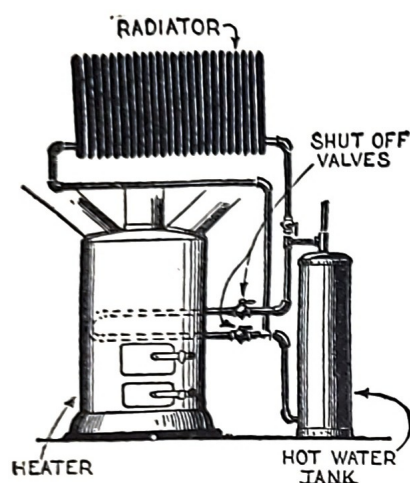
Bench Anvil



By sawing the handles off an old flat-iron and cutting a receptacle to fit the body of the iron on the work bench a very useful bench anvil is made.

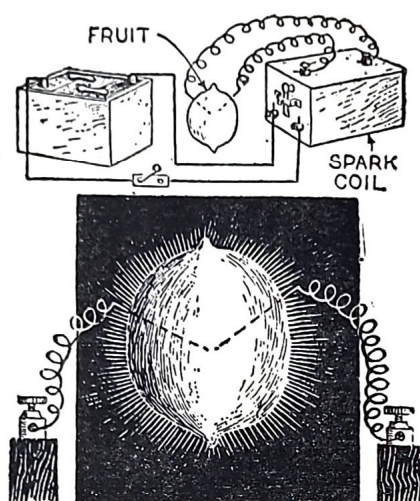
—Chas. T. Allen.

Heater



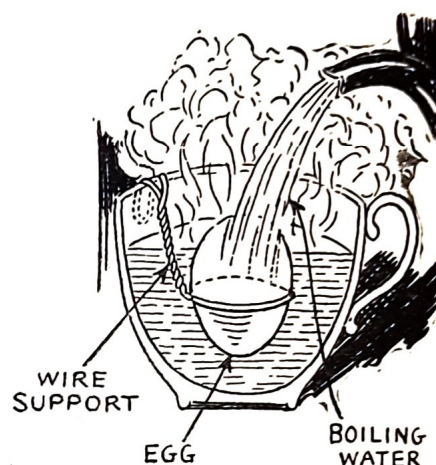
An old hot-water radiator may be used to warm some part of a house, equipped with a hot-air furnace, which part may be ordinarily rather cool in winter. A loop of pipe and its attendant fittings as shown above are all that is required. —H. T. Schuesen.

Luminous Objects



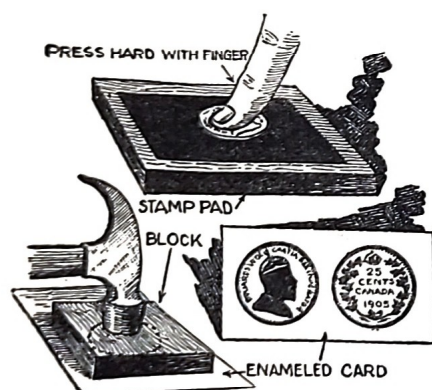
If two heavy wires are pushed into an orange or lemon as shown above and hooked up to the secondary of a spark coil, a pretty luminous effect will be obtained. A gap should be left between the ends of the two wires. A cake of soap will exhibit the same effect. —Joseph Mersand.

Boiling Eggs



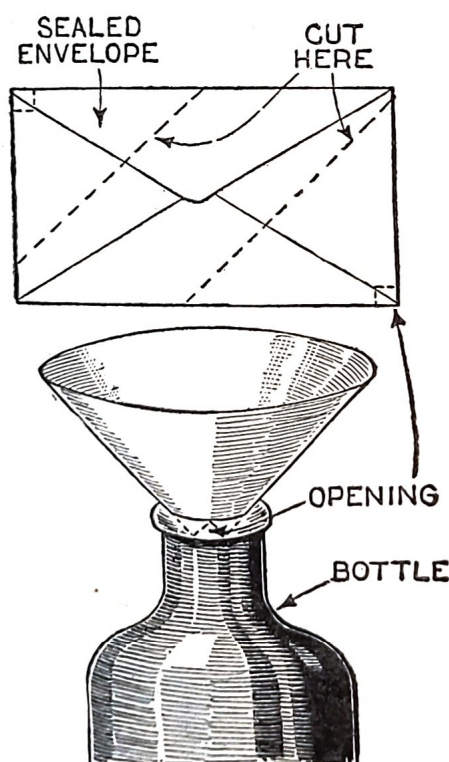
A safe way of cooking medium hard eggs is shown above. In this way, the egg cannot be overdone. Make a wire frame as shown, place the egg in position and cover with boiling water. At any time after 5 minutes, remove the egg and it will be done. —C. A. Oldroyd.

Coin Record



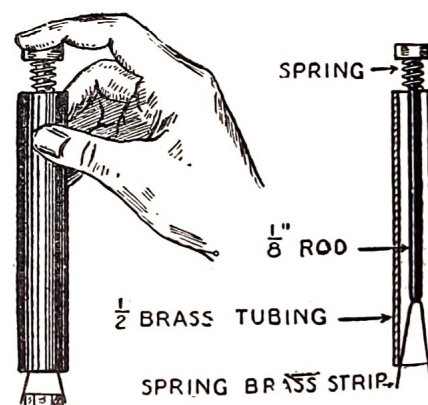
A coin collector may record his coins for filing purposes as above. Press coin on stamp pad, remove and lay it on a finely finished sheet of cardboard and tap as shown. The result is illustrated. —Wilbert Whitfield.

Funnel



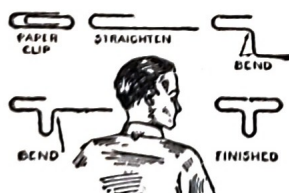
Where powdered chemicals are to be placed in a comparatively narrow mouthed bottle, a simple funnel cut from an envelope as shown above comes in handy. Two may be obtained from one envelope. —C. A. Oldroyd.

Nut Holder



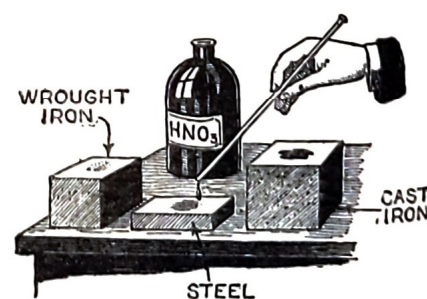
With the device shown above, nuts may be started in places which the fingers cannot reach.

Collar Button



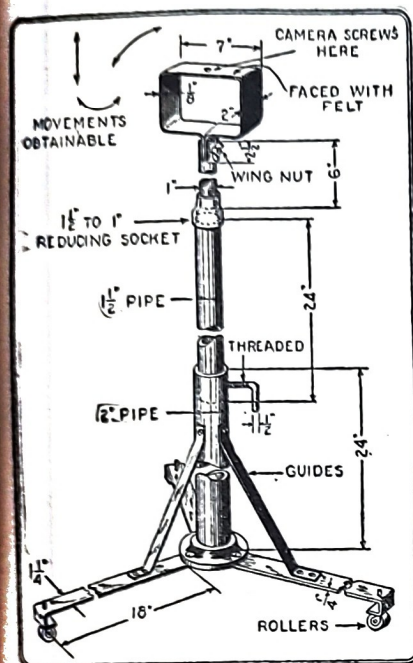
An ordinary paper clip of the type shown when bent as illustrated makes an excellent collar button. A fastener of this nature cannot cause a bulge in the back of the collar. —H. C. Frante, Jr.

Iron Test



Nitric acid on cast iron yields a deep blue color; on steel, a brownish black or dark gray, while on wrought iron it gives a pale gray. —E. R. Caley.

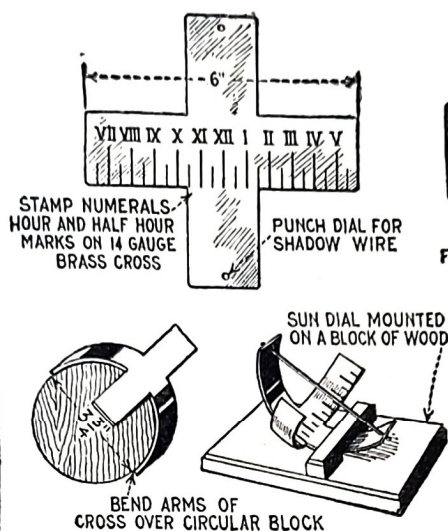
Camera Tripod



A tripod stand for the studio that is very rigid and adaptable to most cameras can be made from pipes and pipe fittings as shown above. The height of the tripod is regulated by means of the telescoping tubes. The strap iron guides shown are not absolutely necessary but they increase the rigidity of the entire tripod. The type of top shown gives a tilting capacity when desired, thus increasing the utility of the stand.

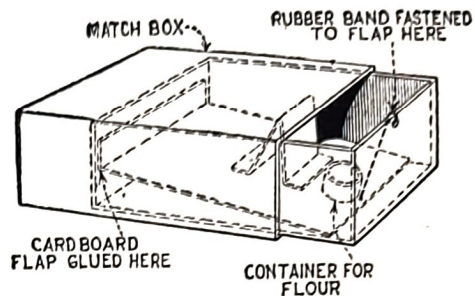
—Raymond B. Wailes.

Sun Dial



To make a fairly accurate sun dial, cut out a cross of 14 gauge brass and stamp or etch hour marks on it as shown, making the hours one-half inch apart. Then drill two holes for the shadow wire and shape the cross arms around a 3 3/4-inch form. Mount as shown and put in the shadow wire. Set the sun dial in a level place with the entire length of the shadow wire in direct line with the north star.—Harold A. Fidler.

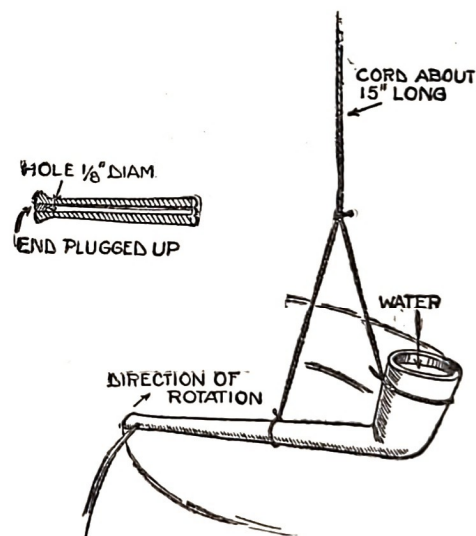
Surprise Match Box



A trick match box that will fool your friends and afford much amusement can be readily made in a very few moments. Glue two bent strips of cardboard in the slide of a match box as shown above. Arrange a rubber band so that it tends to pull the flap upward. However, the triangle of cardboard holds the flap down when the box is closed but upon opening, the rubber band pulls the flap upward and catapults the flour from the cup.

—Alden Henry Johnson.

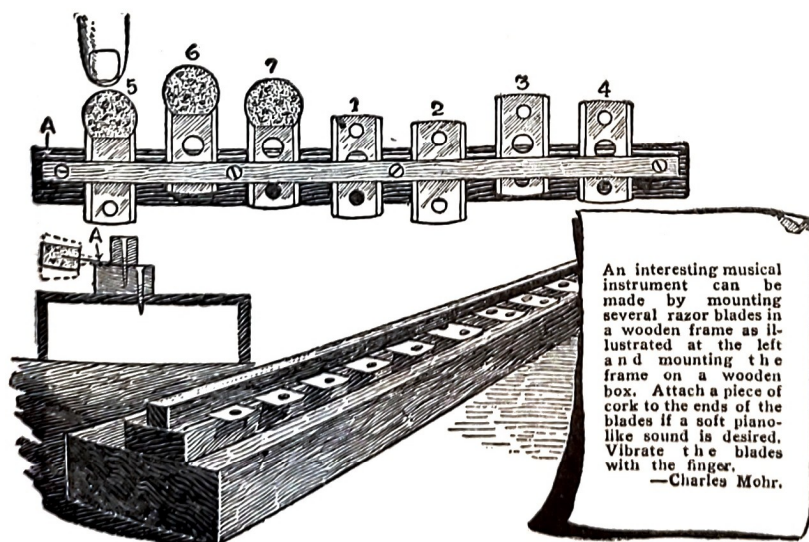
Model Water Turbine



A most interesting working model of a water turbine can be made up in a very simple manner with the aid of a clay pipe and a few pieces of cord. First, the mouthpiece of the pipe stem is plugged up with sealing wax and a horizontal hole is drilled through only one wall of the stem. The pipe is then mounted in a sling made up of short pieces of string and another cord about 15 inches long suspends the potential turbine from any suitable point. If water is poured into the pipe bowl, a jet will escape through the hole at the side and the reaction will rotate the pipe rapidly in a direction opposite to that of the jet. The principle underlying the operation of this model is exactly the same as that of water turbines of the "Francis" type.

—C. A. Oldroyd, Rep. No. 4433.

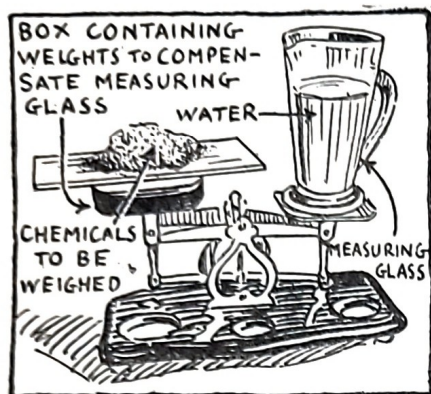
How To Make A Razor Blade Guitar



An interesting musical instrument can be made by mounting several razor blades in a wooden frame as illustrated at the left and mounting the frame on a wooden box. Attach a piece of cord to the ends of the blades. If a soft piano-like sound is desired, vibrate the blades with the finger.

—Charles Mohr.

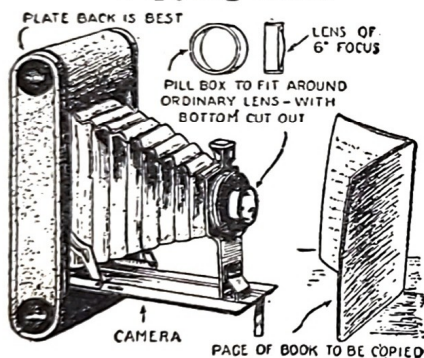
Water as Weights



The experimental chemist whose supply of graduated weights is limited may use water instead. Place a graduate on one pan and a weighted box on the other to balance. Then each cubic centimeter of water in the graduate will balance one gram in the opposite pan.

—C. A. Oldroyd.

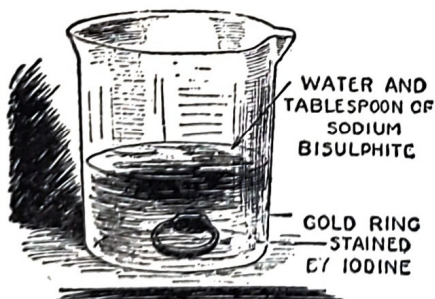
Copying Lens



A lens of 6 inch focal length mounted in a pill box and placed over the lens of an ordinary hand camera enables the operator to use the same for copying work. It is best to focus on a ground glass as otherwise it will be necessary to experiment for the correct position.

—Don Home.

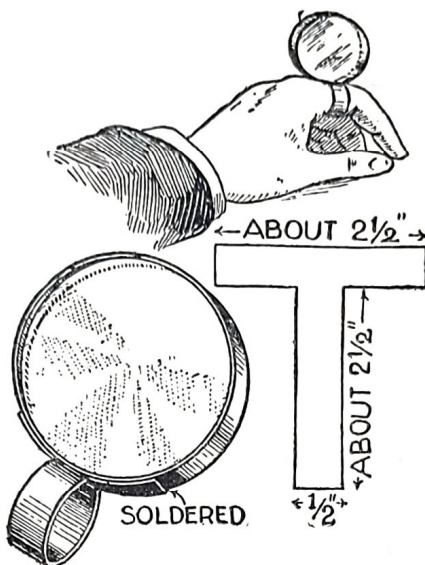
Cleaning Rings



If a gold ring or coin which has been stained with iodine is immersed in a solution of sodium bisulphite for about 15 minutes, the stain will disappear.

—Franklin Price.

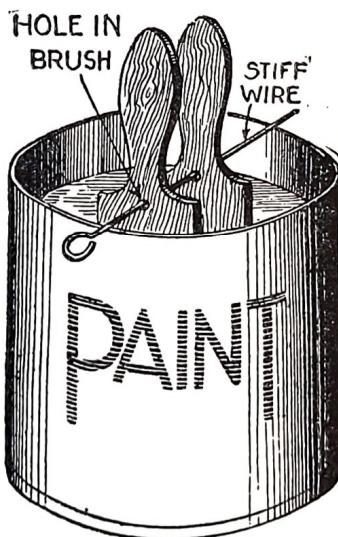
Glass Holder



When reading fine type or doing other work which requires the constant use of a small magnifying glass, the usual handle with which these glasses are equipped is rather awkward and tires the hand. If a strip of metal is cut to a T shape with the dimensions shown above and soldered to the metal rim surrounding the glass, the combination may be used as shown.

—Truman R. Hart.

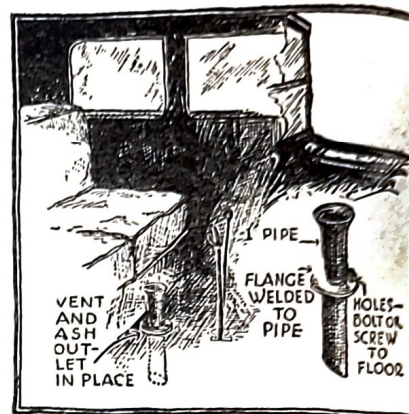
Paint Brushes



When doing painting where two or more different sizes of brushes are required, one of them is often allowed to remain in the paint can, and when required again it is found that a good portion of the handle is covered with paint both from that dripping down the sides of the can and that in the bottom of the container. This can be eliminated if a hole is drilled in the handle of each brush to be used and a stiff piece of wire provided for suspending the brushes as shown in the above illustration.

—C. C. Sorensen.

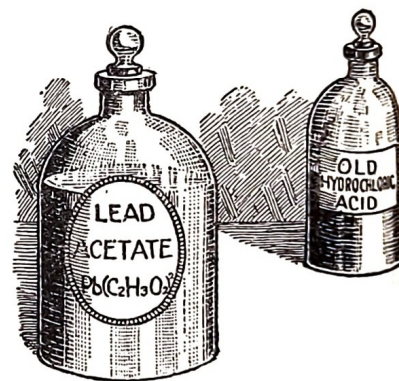
Car Ventilator



A combination ventilator and ash receptacle for the closed car may be quickly made from pipe fittings as shown above. A 1 inch or larger pipe is flared out at one end and a flange welded to it as shown. The lower end of the pipe is cut off at an angle. Mounted in the floor board as shown, this accessory is very handy as an ash tray and also serves as a ventilator.

—Thomas McCartie.

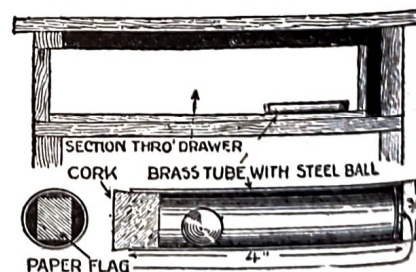
Cleaning Bottles



When reagent bottles have been allowed to stand, they are often hard to clean. However, if some old waste hydrochloric acid is placed in the bottle and rolled around the sides it will quickly dissolve the deposit. The bottle is then washed as usual.

—Carlyle Weiss.

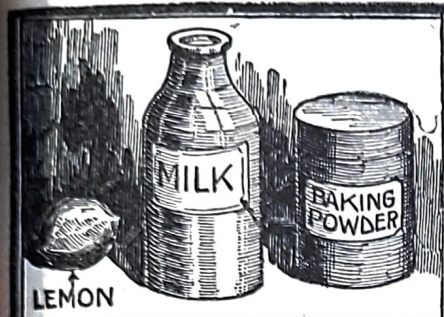
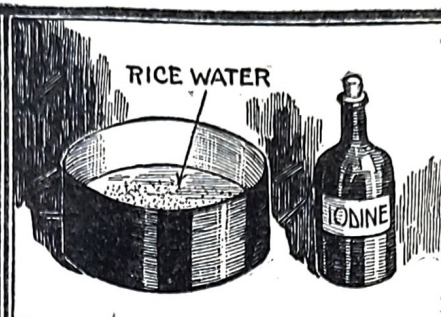
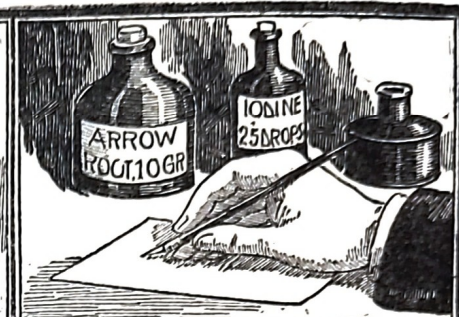
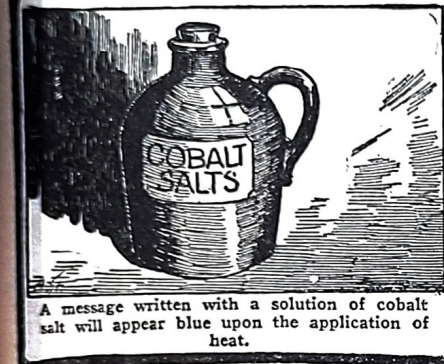
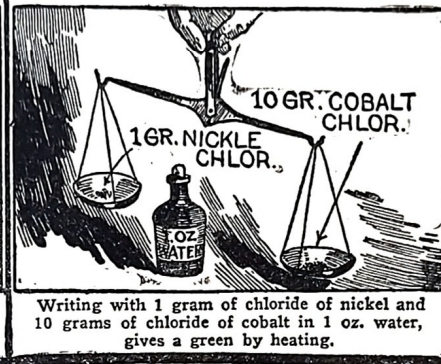
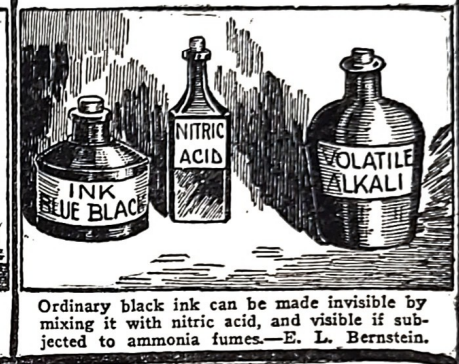
Mechanical Detective



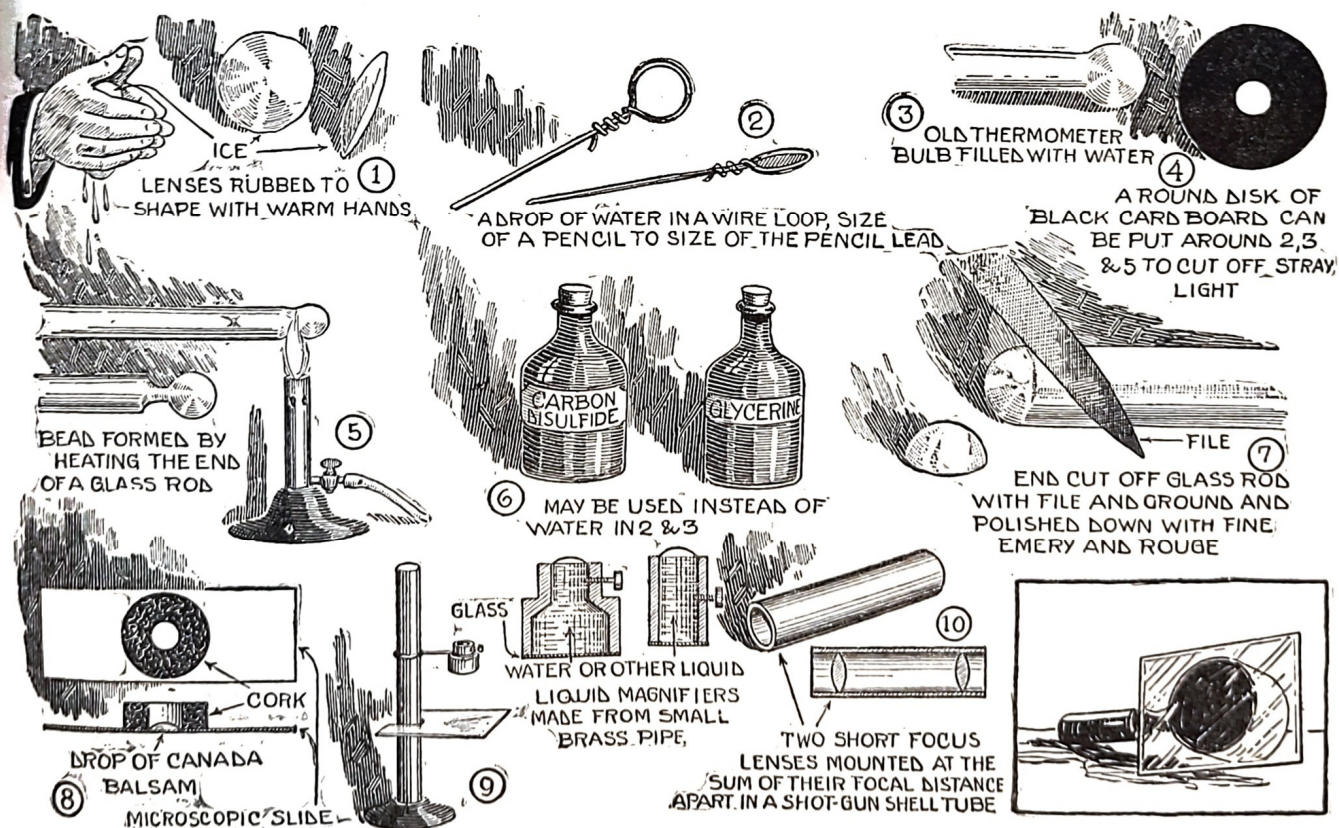
To find out if anyone has opened a drawer during one's absence, make the little device shown above, closing one end of the tube with a small paper strip. If the drawer has been opened, the paper will be found out of the tube.

—C. A. Oldroyd.

Invisible Inks

 LEMON	 RICE WATER IODINE	 ARROW ROOT, 10GR IODINE 25DROPS
If writing is done with lemon, milk or a solution of baking powder in water, the message will become visible when heated.	If the message is written with rice water, it can be made visible with iodine to the surface. Used by East Indians in their writing.	An ink which will fade in a few days is made by dissolving some arrow root in water, and adding 25 drops of iodine when cold.
 COBALT SALTS	 10GR. COBALT CHLOR. 1GR. NICKLE CHLOR. 1 OZ WATER	 NITRIC ACID VOLATILE ALKALI INK BLUE BLACK
A message written with a solution of cobalt salt will appear blue upon the application of heat.	Writing with 1 gram of chloride of nickel and 10 grams of chloride of cobalt in 1 oz. water, gives a green by heating.	Ordinary black ink can be made invisible by mixing it with nitric acid, and visible if subjected to ammonia fumes.—E. L. Bernstein.

Home Made Microscopes



1 LENSES RUBBED TO SHAPE WITH WARM HANDS

2 A DROP OF WATER IN A WIRE LOOP, SIZE OF A PENCIL TO SIZE OF THE PENCIL LEAD

3 OLD THERMOMETER BULB FILLED WITH WATER

4 AROUND DISK OF BLACK CARD BOARD CAN BE PUT AROUND 2, 3 & 5 TO CUT OFF STRAY LIGHT

5 BEAD FORMED BY HEATING THE END OF A GLASS ROD

6 CARBON BISULFIDE GLYCERINE MAY BE USED INSTEAD OF WATER IN 2 & 3

7 END CUT OFF GLASS ROD WITH FILE AND GROUND AND POLISHED DOWN WITH FINE EMERY AND ROUGE

8 DROP OF CANADA BALSAM MICROSCOPIC SLIDE

9 GLASS WATER OR OTHER LIQUID LIQUID MAGNIFIERS MADE FROM SMALL BRASS PIPE

10 TWO SHORT FOCUS LENSES MOUNTED AT THE SUM OF THEIR FOCAL DISTANCE APART IN A SHOT-GUN SHELL TUBE

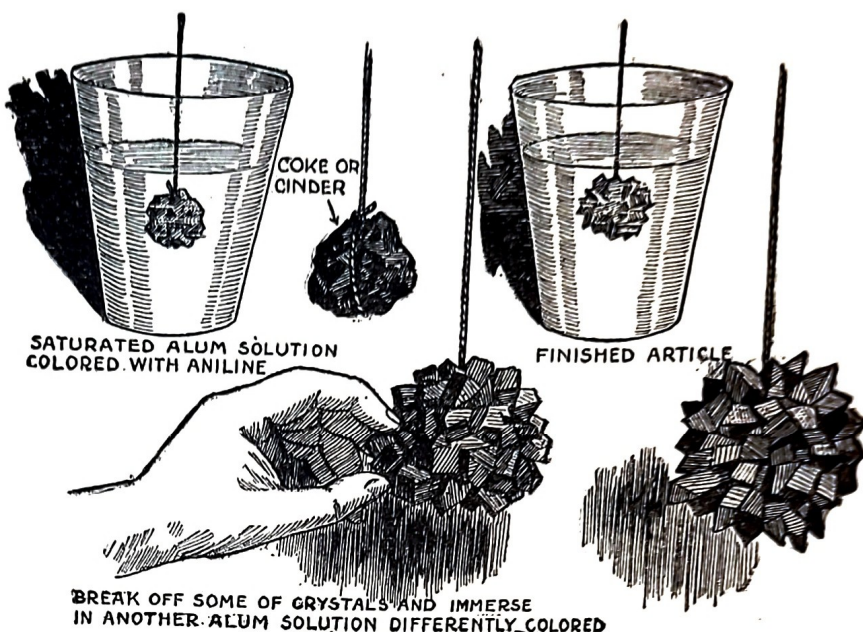
The first lens is made by rubbing ice into shape with warm hands. Two is a drop of water on a wire loop. A black disk should be placed around 2 and 3 to shut off stray light and outside vision. Carbon disulphide and glycerine may be used in the second and third lenses instead of water with slightly

improved results. The microscopes made with the aid of pipe fittings shown at 9, are very good, since the degree of convexity of the surface may be controlled with the thumb screws in the sides of the fittings. The lens shown at 7 is a real one and very good.

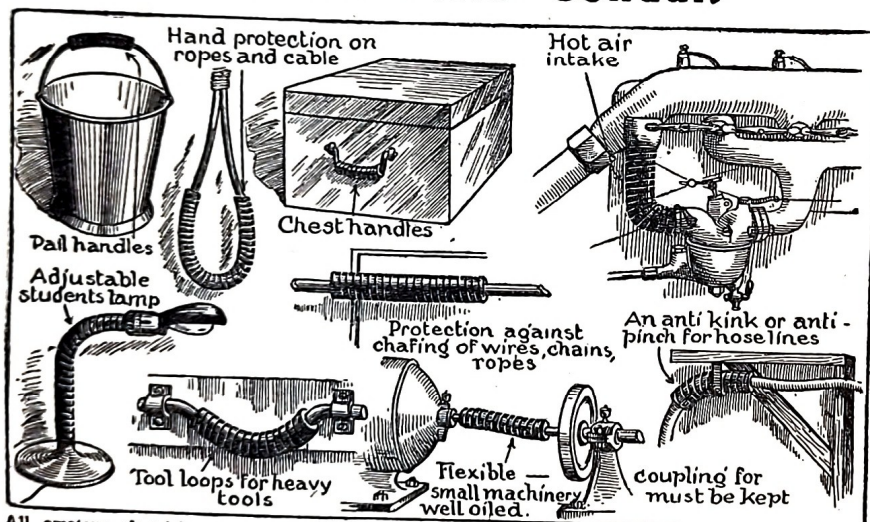
—Cecil Edgar Payne.

How to Make Colored Crystals

It is well known that beautifully formed crystals can be made by hanging pieces of coke or cinders in a saturated solution of alum. We can, however, go a step further than this and obtain beautifully colored crystals if we add an aniline dye to the alum solution. With a little care, crystals with two or more bright shades of color may be obtained. First prepare several alum solutions by adding as much alum to boiling water as can be dissolved. Color the different solutions strongly with dyes. Suppose that you make up a blue, a red and a yellow solution. Hang the coke or cinder in the red liquid and allow it to remain there until a large series of crystals is formed. Remove from the solution and break away several of the moist crystals. Allow the mass to dry and hang in the blue solution. Crystals will only be deposited on the exposed rough parts of the coke and they will be of a different color. Repeat the same procedure and use the yellow solution. You will then have a gleaming mass of crystals having three separate and distinct colors throughout. Do not forget to let each series of crystals dry before placing in the next solution.—S. Leonard Bastin.



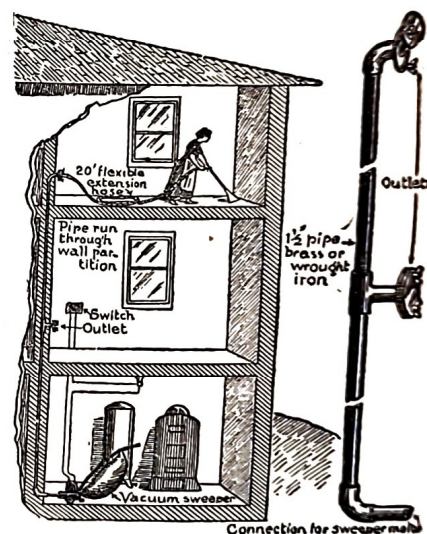
Uses for Scrap Conduit



All amateur electricians are confronted with the problem of disposing of scrap bits of conduit. Amateurs do not like to throw away anything—that's why they are amateurs. Above is shown some of the many ways scraps of flexible conduit, too short to use in regular wiring, may be put to use. Any number of handles may be made by placing short strips of the flexible metal over stiff wire or cord. If there is a piece of larger diameter available it will be found very handy in constructing a hot air lead for the carburetor of the car. If a couple of the end fittings are handy, a very presentable study lamp can be made, as shown.

—C. R. Mullin.

Cleaner Kink

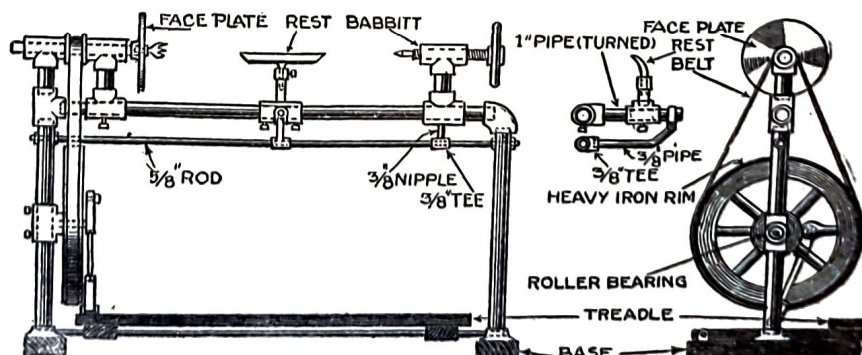


By passing a pipe line up through the partitions of a house and fitting it with plugs on each floor and attaching it to the vacuum cleaner in the basement and using a hose with a nozzle time can be saved.

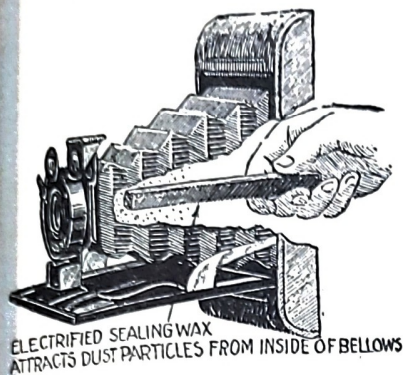
—G. A. Luera.

Lathe

With a little ingenuity and patience, anyone handy with tools can produce a foot-power wood turning lathe that will give excellent results. The materials used consist mainly of pipes, pipe fittings and iron rods. Wood strips are used for the treadle and the mounting bases. The wheel from which the belt transmits the power to the face plate may be an old wagon wheel equipped with a heavy iron rim so as to give a fly-wheel effect. The bearings consist of pipe tees filled with babbit. The latter metal may also be used for holding the adjustable tail-stock screw in position. The details of the tool rest are shown. Here again pipe fittings are used in the construction. The tool rest may be purchased or made as desired.

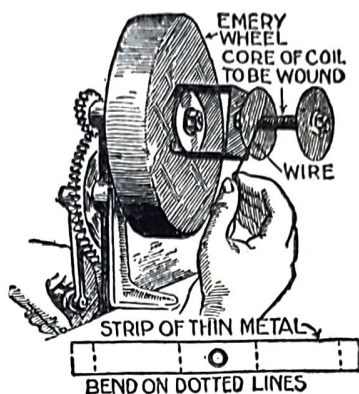


Cleaning Camera



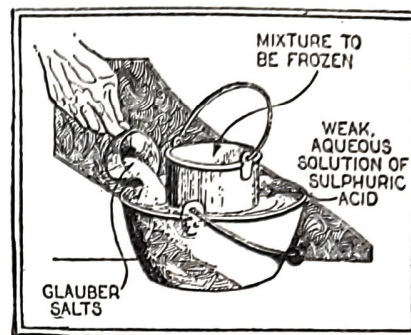
The interior of a camera often accumulates dust and fine particles of material which are liable to collect on the lens. This is particularly true in the case of small hand-cameras where the bellows is opened and closed frequently, thereby stirring up the dust. To remove this material, electrify a stick of sealing wax by rubbing it with a piece of flannel and hold it in the bellows as shown above, moving it around. —C. A. Oldroyd, Rep. 4433.

Coil Winder



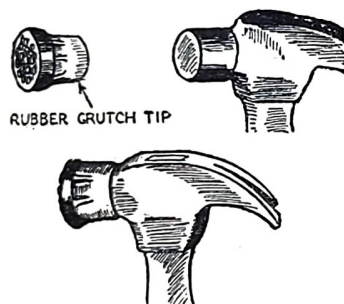
The gearing of an ordinary emery wheel can be utilized to advantage in constructing a coil winder. A strip of metal for supporting the core is bent and drilled as shown above, the nut holding the emery wheel to the shaft is loosened, and the ends of the metal strip slipped under the washer. The nut is then tightened. —Charles Craft.

Freezing Mixture



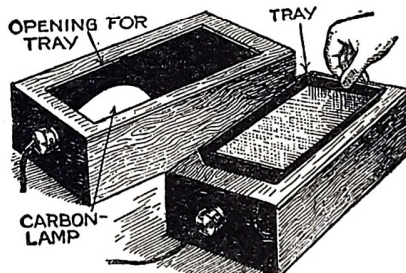
The mixture to be frozen is placed in a pail which in turn is placed within a large bucket as shown in the above illustration. A cold weak water solution of sulphuric acid is poured into the outer container and a half cup full of Glauber's salts added. It is possible to freeze ice cream using this method. —Philippe A. Judd, Rep. No. 7297.

Rubber Mallet



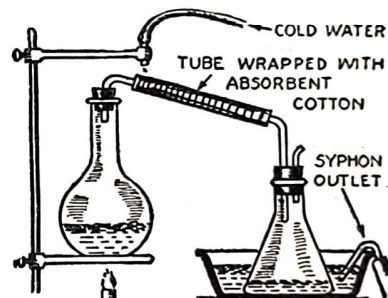
When a rubber mallet is required for a certain job and a regulation one is not at hand, a substitute may be made as illustrated above. A rubber crutch tip is procured and placed over the end of a standard hammer as shown. The rubber must usually be stretched when placing the tip on a hammer and this tension holds the tip in position. —Adolph Lonk.

Tray Heater



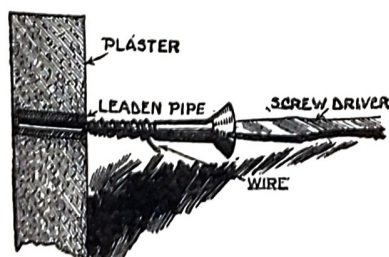
In cold weather, developing trays in photographic work become so low in temperature that the developer is very slow in action. A heater made as above will remedy this. A carbon filament lamp is mounted in a cigar box, in the top of which an opening is cut as shown. The tray is placed over this opening and the heat from the lamp heats the chemicals. —L. B. Robbins.

Condenser



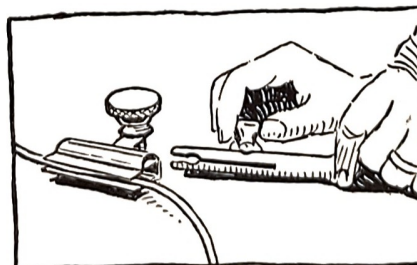
An easily made and quickly constructed condenser for distillation purposes may be put together as shown above. A bent glass tube conducts the vapors which are cooled and condensed in their passage. The conducting tube is wrapped with absorbent cotton or cloth and cold water allowed to drip upon it. The cooling action of the water condenses the vapors. —Carlyle Weiss.

Screw in Plaster



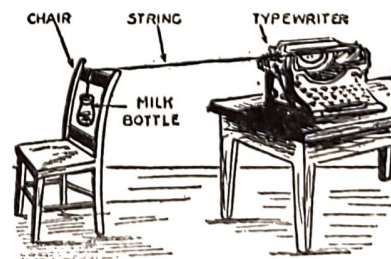
Ordinary wood screws may be made to hold in plaster by first drilling a hole, driving a section of lead pipe therein and then turning in the screw prepared with a wire as shown above.

Pinchcocks



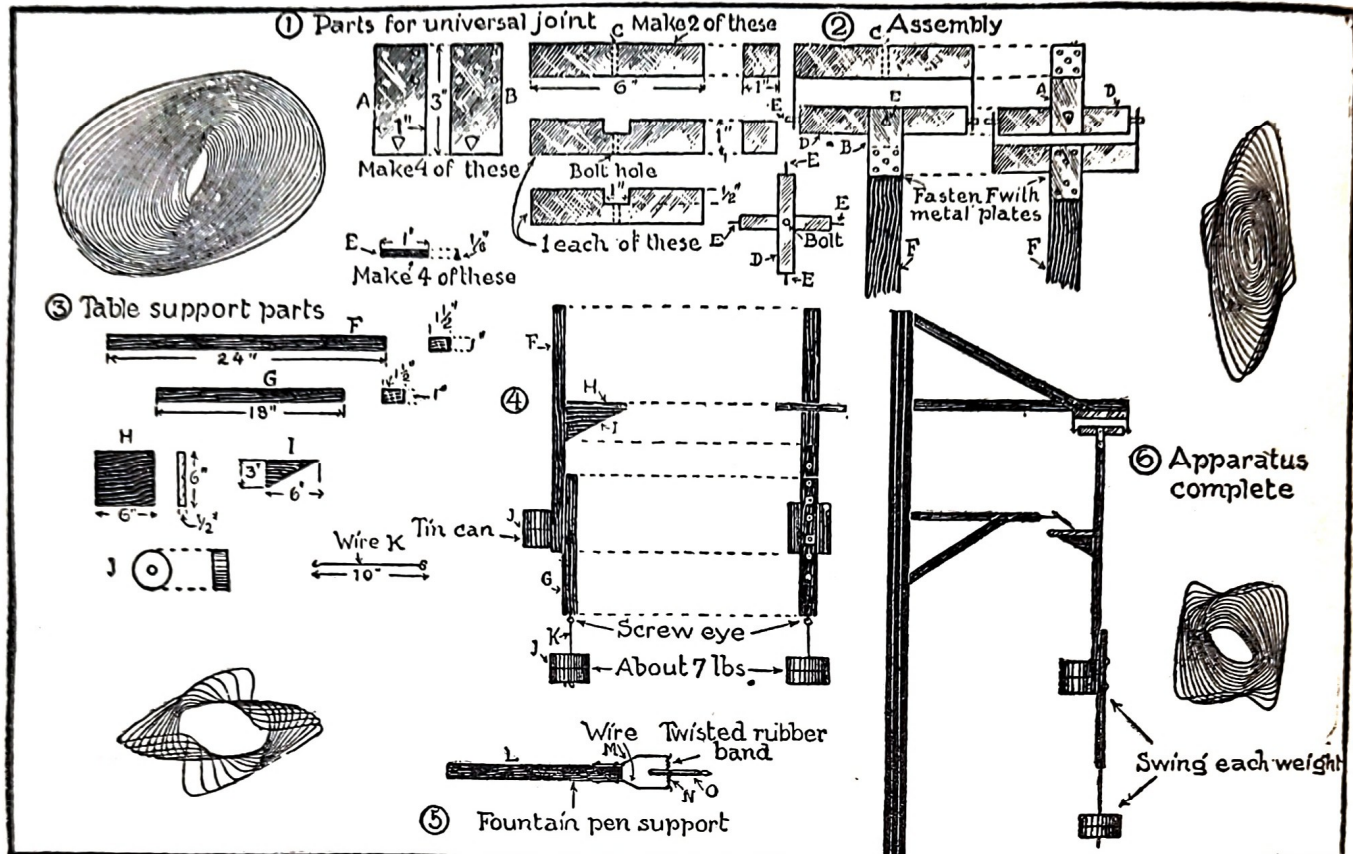
Emergency pinchcocks may be quickly and easily made from clothespins and letter clips as illustrated above. Adjusting screws equipped with wing nuts allow exact regulation of the pressure on the rubber tubing. —C. A. Oldroyd, Rep. No. 4433.

Spring Substitute



When the carriage spring of a typewriter breaks at a time when it is most needed, a substitute may be arranged as shown. The weight of the milk bottle operates the carriage as would the spring. —A. P. D'Ambra.

Making a Traceograph

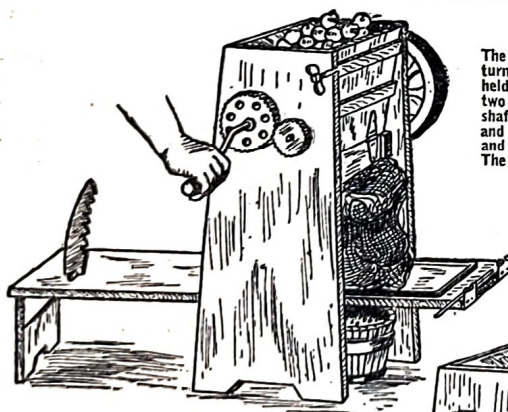


The traceograph, as shown in the above diagram, is very simply made, and the experimenter should find no end of pleasure in operating it after it has been once constructed. It will be seen that there are two weights on the traceograph, both of which are drawn

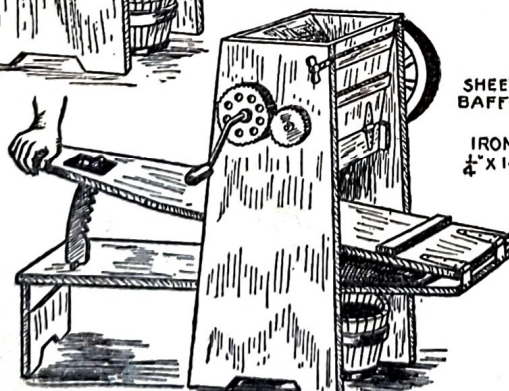
away from the vertical and released simultaneously. The platform upon which the paper is mounted (H) will swing and the pen (O) will draw various geometrical figures. Several samples of the work will be found on this page.

—Constantine Troy.

Building a Cider Mill

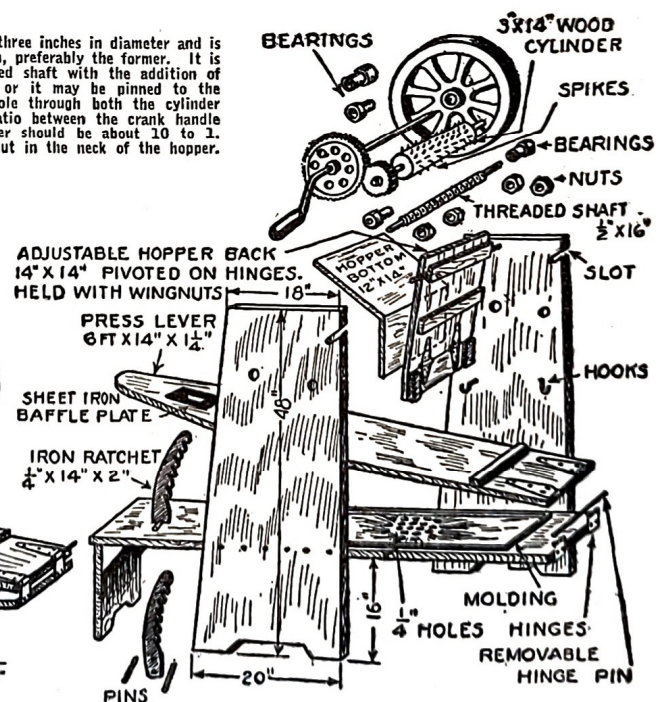


The back of the hopper is made removable and is held in place while the machine is in operation by two wing nuts. The bolts upon which these nuts are located, fit into the two slots in the side boards. Hooks are installed below the hopper in the side boards for holding the sack which catches the crushed apples.



An easily made cider mill pictured in the above illustrations, has a capacity of two barrels of cider per day. The shafting gears, bearings and fly wheel, are taken from discarded machinery, and the dimensions of the mill will depend upon their selection. The bottom of the press, the lever and the side boards, should be made preferably of oak.

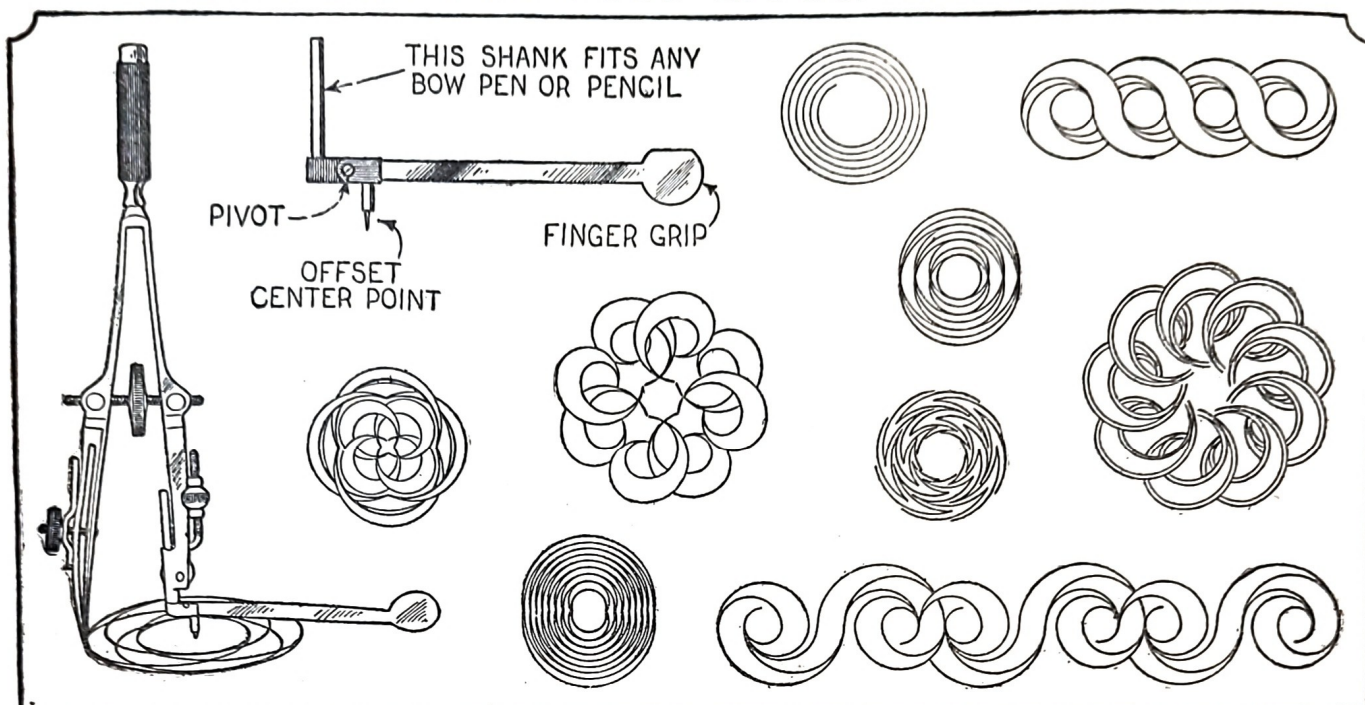
The grinding cylinder is three inches in diameter and is turned from oak or beech, preferably the former. It is held on either a threaded shaft with the addition of two nuts on each end, or it may be pinned to the shaft after drilling a hole through both the cylinder and shaft. The gear ratio between the crank handle and the grinding cylinder should be about 10 to 1. The spiked cylinder is put in the neck of the hopper.



The grinding cylinder is made of wood, into which headless spikes are driven. The lever which presses the juice from the pomace, is mounted on removable hinges. The entire weight of a man exerted at the distant end, will be sufficient to press the juice from this pomace, which is caught as it comes out of the hopper in a sack. The iron ratchet is used to relieve the pressure.

—Tud Garber.

Compass Kink for Irregular Designs

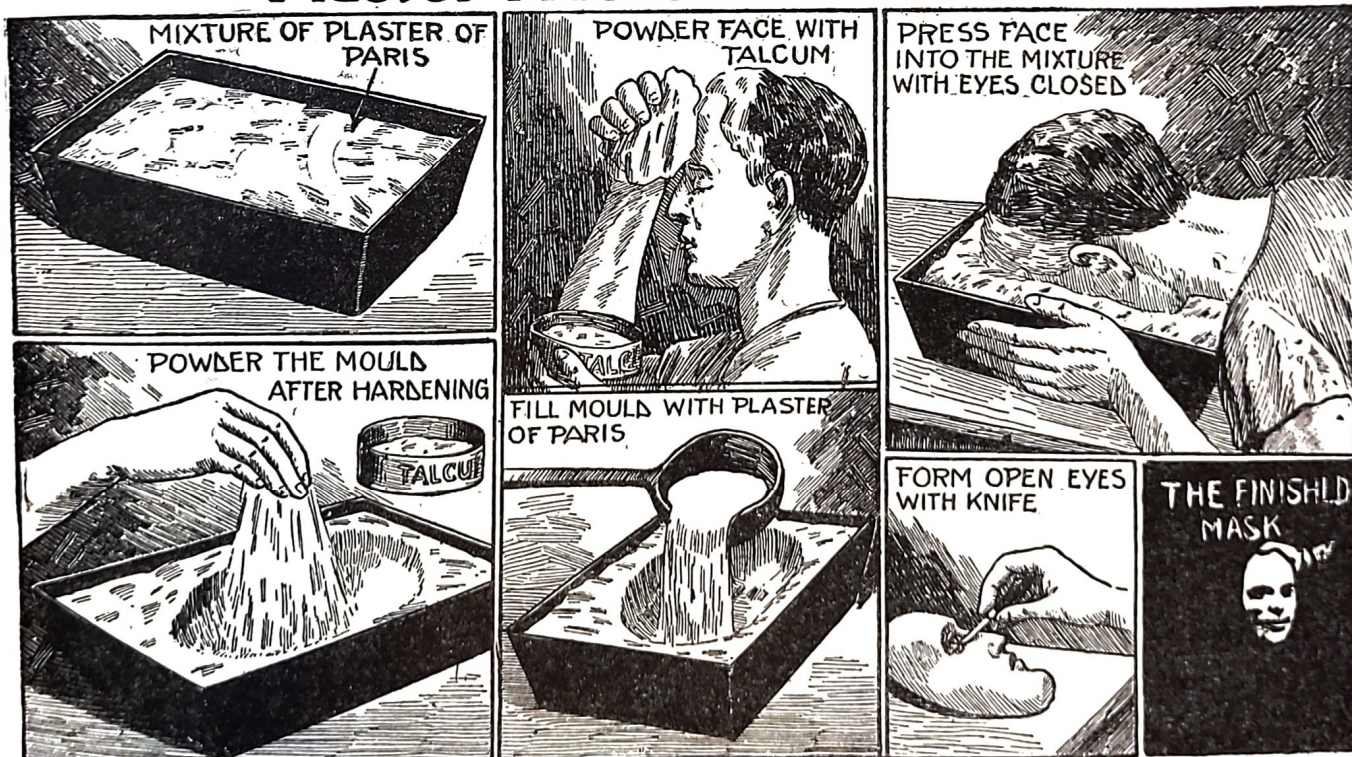


Amateurs usually experience a great amount of trouble in producing special designs. The writer, finding several of these necessary, hit upon the scheme shown above for producing them with almost perfect symmetry. The regular center point of the compass is replaced by a movable off-center point attached to a finger grip, as shown in the illus-

tration. The shank of the attachment fits any bow pen or pencil. A little practice on the part of the operator and any of the figures shown above, as well as a large number of others, may be produced. If a true circle is desired, it is only necessary to let the finger grip rotate with the compass.

—Justin Hurley.

Plaster Masks Simply Made



Masks may be easily made at home, and if a little care is taken, there is no reason why they should not be fully as artistic as the professionally made articles. First make a mixture of plaster of Paris and water of the consistency of thin dough; then powder the face thickly with talcum. Press

the face into the plaster of Paris with the eyes closed. It will be necessary that the consistency of the plaster be proper, so that the features of the face will be retained. Then powder the mould and pour in the plaster for the cast. Form open eyes with a knife.

—R. C. Leibe.

Window Cleaner



PIVOT BOLT THROUGH SASH FRAME

A discarded automobile windshield cleaner comes in handy when attached to a window frame as shown above. During storms, it permits those inside the house to obtain a clear view outside.

—L. B. Robbins.

There are a number of variations of this idea which lend themselves very nicely to home uses. By placing more than one windshield wiper on a sash, practically the whole window can be kept clean when desired. Another trick which will help to keep the window free from sleet and rain is to wipe the outside of the glass with one of the well-known "clear-view" pads sold at auto supply stores which, after its application, prevents water from accumulating on the windshield.

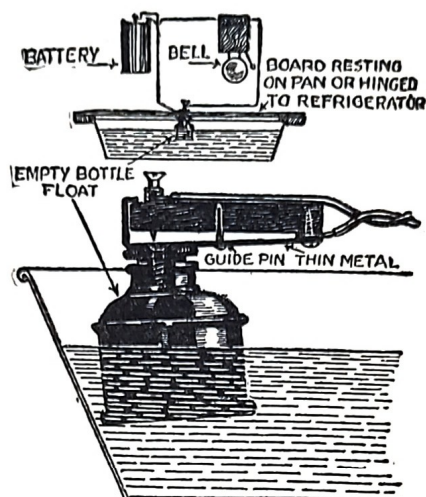
Burning Steel



A piece of steel wool, if placed in the flame of a Bunsen burner for a second and removed, will emit bright flashes for about ten seconds.

—Arthur A. Blumenfeld.

Overflow Alarm

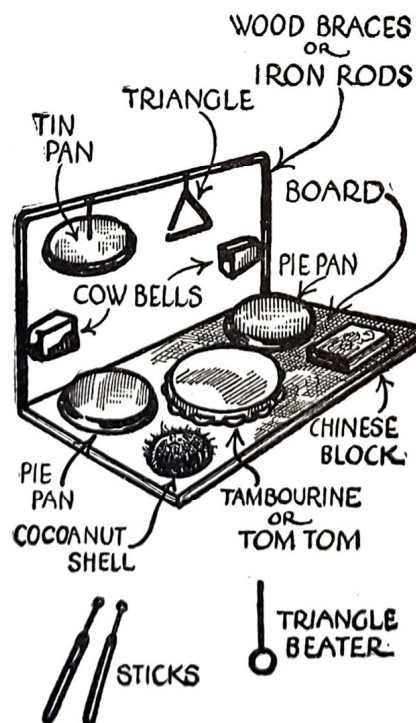


An alarm to be placed in the drip pan of a refrigerator to sound when the pan is full, may be made as shown above.

—G. W. Beerbwer.

There are a number of variations of this idea for an overflow alarm which will suggest themselves to the ingenious experimenter and home mechanic. A small hollow copper bowl or similar device may be used very well in place of the empty bottle here shown. In the event that it is desired to use a red "tell-tale" signal light, instead of the bell, or in conjunction with it, this can easily be arranged by means of a relay operated from the contact illustrated in the diagram above.

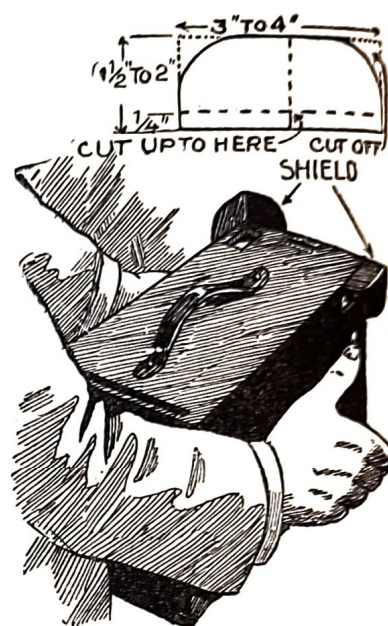
Trap Drums



The various instruments shown above when mounted as indicated make quite a respectable set of trap drums. Two drum sticks and a triangle beater are also necessary.

—John W. Reed.

Camera Shield

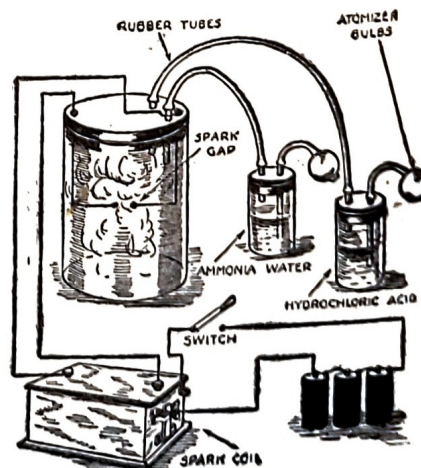


When using large hand cameras, it is often difficult to properly shield the finder with the hand so as to obtain a clear view. This difficulty can be overcome by cutting two shields from sheet tin in the shape shown above and attaching to the camera.

—Andrew Chlpka, Sr.
Reporter No. 8081.

There are a number of useful kinks in the camera world which will prove themselves very useful, and a device seldom seen on ordinary box cameras, yet valuable indeed, is a spirit level. Special duplex spirit levels are available at camera shops, or two ordinary single tube levels may be purchased and mounted one on each side of the camera. Delayed time element trips are very useful in taking pictures of birds, animals and other odd photos.

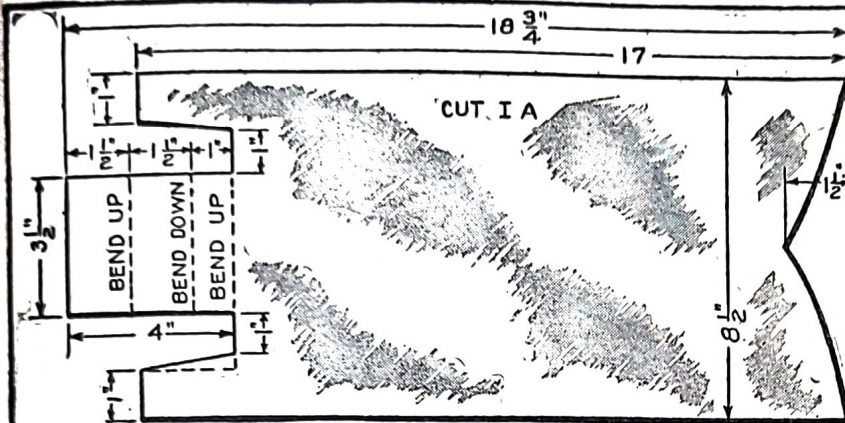
Vanishing Smoke



A demonstration of the Cottrell system for precipitation of smoke may be made as shown above. The two gases mingling form smoke. Passing a spark through the smoke precipitates the particles.

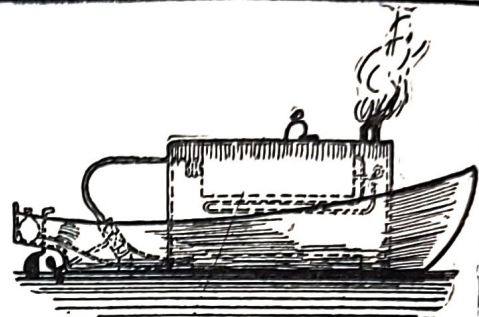
—Francis D. Whittemore, B. S.

Steam Propelled Model Boat



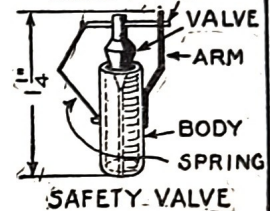
The turbine is built in a metal pill box with small brass vanes. The steam jet blows into one side, so the steam impinges upon the blades.

—F. E. Peterson.



The detail of the safety valve is shown below. The piece of lead forming the valve is cut or filed as shown and fits into the top of a brass pipe which is soldered to the boiler top. The supporting spring can be made of brass wire.

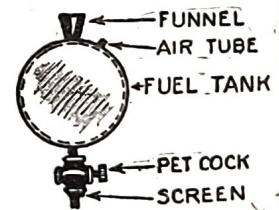
CROSS PIECE



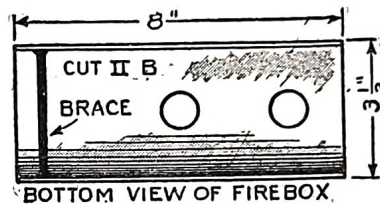
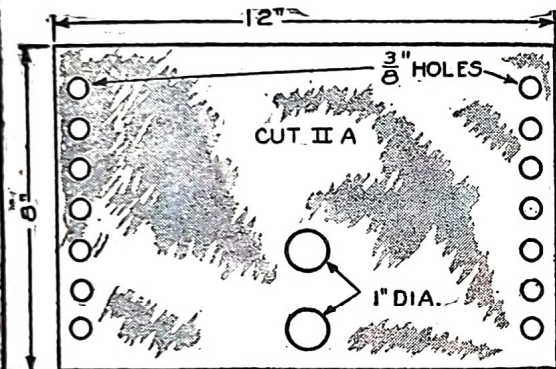
SAFETY VALVE



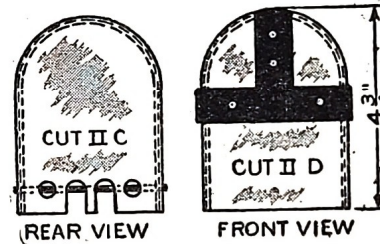
PROPELLER



FUEL TANK

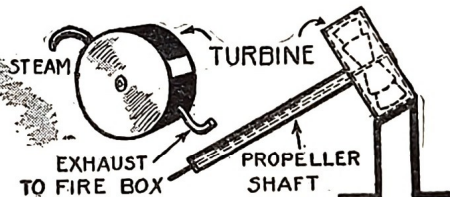
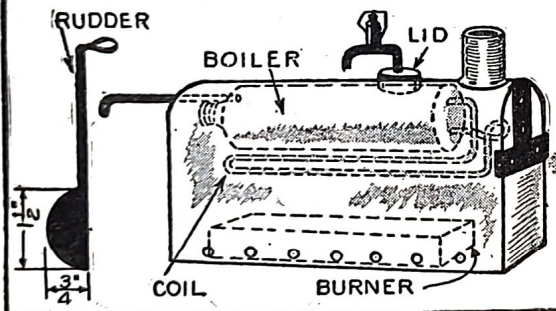


BOTTOM VIEW OF FIREBOX



REAR VIEW

FRONT VIEW



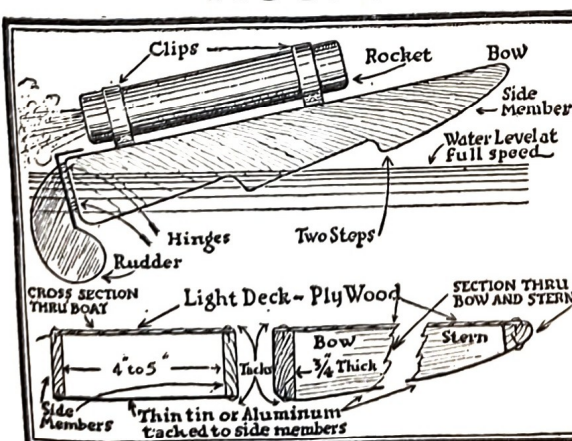
EXHAUST TO FIRE BOX

PROPELLER SHAFT

The turbine propelled boat constructed entirely of metal shown in the above illustration, is extremely simple to build and the materials may be obtained from scraps found about the home. Cut IA is the hull and is

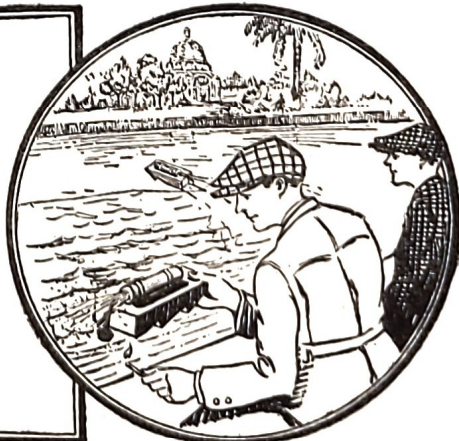
bent as shown, the joints being soldered. The forward hole takes the smoke stack and the one just behind it the boiler lid. The burner is a sardine box filled with wicking. The fuel tank is aft.

Rocket Propelled Speed Boat



The speed boat shown in this illustration is propelled by a rocket which is fastened to the deck with the aid of two clips. The boat is made in the shape shown at the left, the two side pieces being made of thin but strong wood, as is the top, while the bottom is of tin or aluminum. The boat is put together with tacks. The rudder is left to the ingenuity of the builder. Of course, it will be necessary to fire the rocket with the aid of a fuse for the protection of the operator.

—C. A. Oldroyd.



Some Interesting Fountains

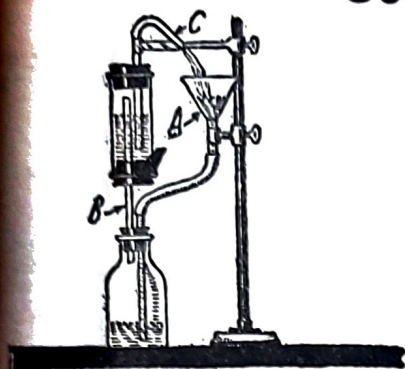


Fig. 1

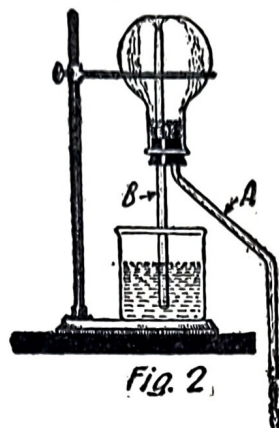


Fig. 2

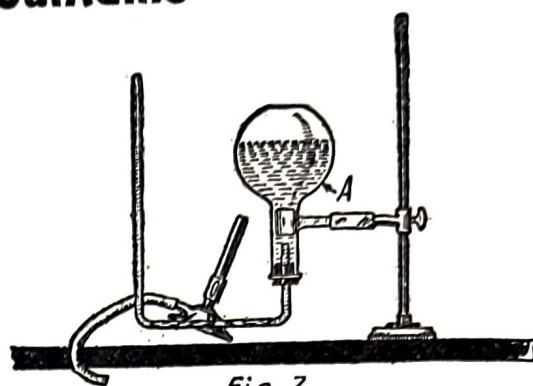


Fig. 3

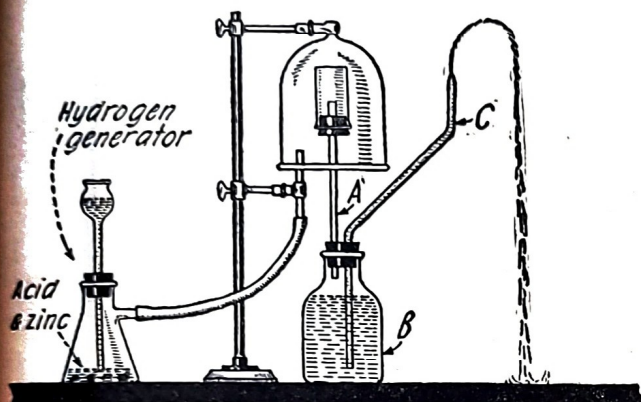


Fig. 4

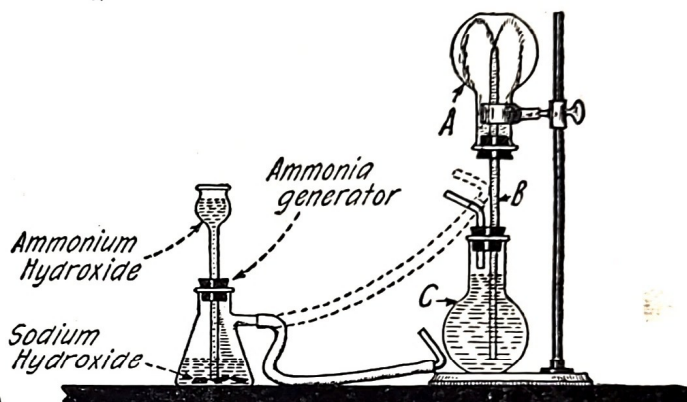


Fig. 5

Fig. 1.—In this Hero's fountain the column of water in the funnel A and tube compresses air in the bottle. This pressure causes flow through C, back into A. The fountain will operate until water in the upper vessel is exhausted. Fig. 2.—In this siphon fountain the partial vacuum caused in the flask by the water escaping through tube A, causes an inrush through B. Fig. 3.—This illustration shows a steam fountain. Rapidly accumulating steam pressure on the surface of the water in the flask A causes the water to be forcibly ejected from the tube. Fig. 4.—This fountain operates on the varying diffusion

rates of gases. Hydrogen introduced into the bell jar diffuses through the walls of the unglazed porcelain cell supported on the tube A much faster than the air in the cell escapes. This causes an internal pressure which causes water to be ejected through C. Fig. 5.—An absorption fountain, started by blowing a little water from C into A, the latter filled with ammonia gas. The water dissolves some of the ammonia, producing a partial vacuum. More water rushes in, and the fountain continues until A is almost filled and the water absorbs all of the ammonia. —Chas. D. Tenney.

Home-Made Laboratory Apparatus

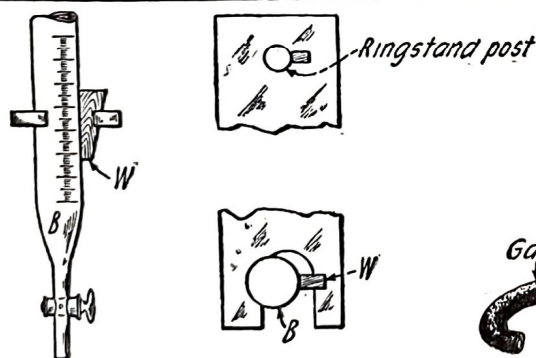


Fig. 1

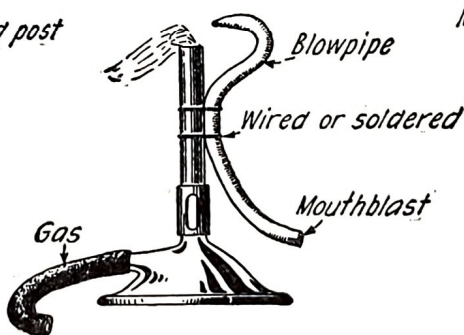


Fig. 2

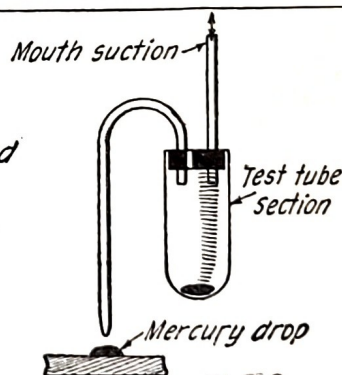


Fig. 3

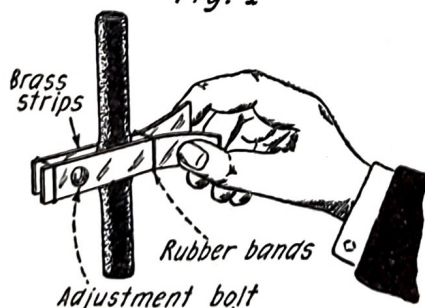


Fig. 4

Fig. 1.—This simple burette holder is made of cigar-box wood. It is easily adjusted by means of the wedge and is entirely practical. Fig. 2.—A jeweler's blowpipe soldered or wired to a Bunsen burner as shown makes a useful soldering or blowing device that leaves both hands of the operator free. Fig. 3.—This pipette is useful for recovering spilled mercury or handling poisonous liquids. There is no danger of sucking the liquid into the mouth. Fig. 4.—This simple pinchcock is easily made from two strips of brass bent as shown and held together by a bolt. Two rubber bands supply the necessary tension. Fig. 5.—Pocket types of ammeters and voltmeters may be simply and inexpensively converted into desk types with aid of a bit of sheet metal and some cigar box wood.

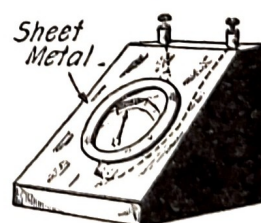
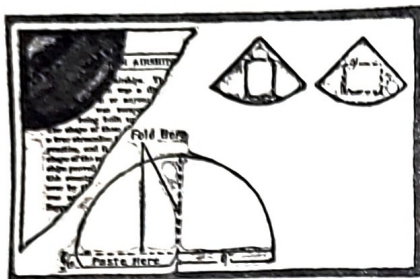


Fig. 5

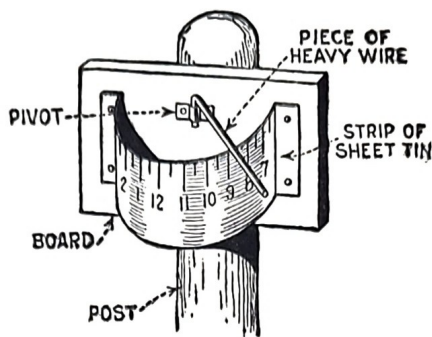
Book Marker



A novel book marker may be made by cutting a semi-circle with a small tab attached from heavy paper or thin cardboard. The exact shape and dimensions are shown above. The semi-circle is folded over and the tab pasted to its adjacent edge. The book mark is used as shown and can be decorated by pasting a photograph on it or by making a sketch in pen and ink.

—T. B. Marsden, Jr.

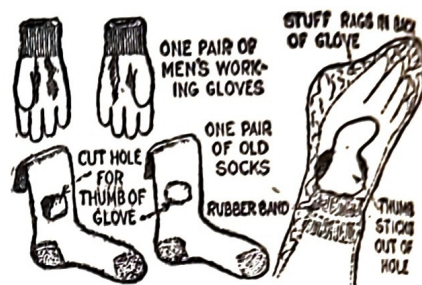
Sun Clock



The details of a unique sun clock are shown above. To read the time, the wire arm is swung until its shadow assumes a vertical position. The correct time is indicated by the shadow as at only one point on the dial will the shadow be vertical at a given time. The figures are inscribed on the dial by setting the sun clock each hour by a watch. In this way the clock is made quite accurate.

—Francis O. Boyd.

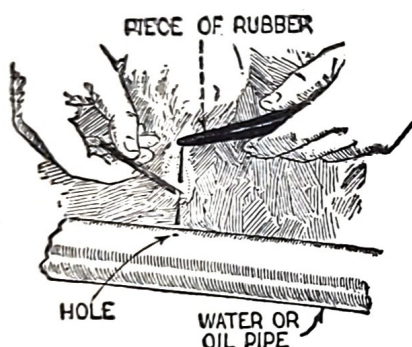
Boxing Gloves



A pair of cheap boxing gloves can be made from a pair of cotton working gloves and an old pair of socks cut short and with holes cut for the thumb of the wearer. The space between the glove and the sock is filled with rags or cotton. A rubber band is placed around the wrist over the glove and another one in about the same position, but over the sock. These retain the finished boxing gloves on the hands.

—Walter Schwartzmiller.

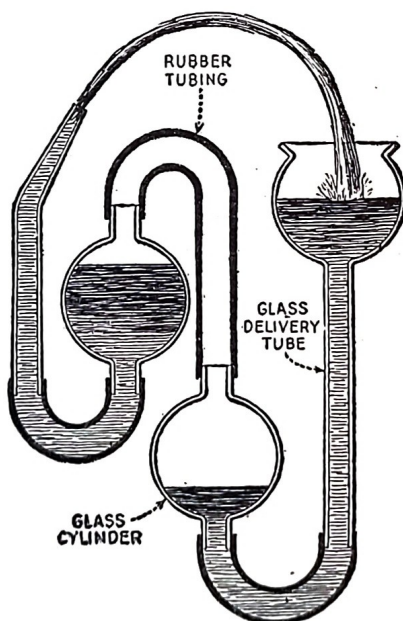
Pipe Repair



A small hole in a water or oil pipe of an automobile can be temporarily mended by melting a piece of rubber over it and allowing the drops to fall over the hole. Make a permanent repair as soon as possible as the rubber will not last.

—Donald Bowie, Jr., Rep. No. 22261.

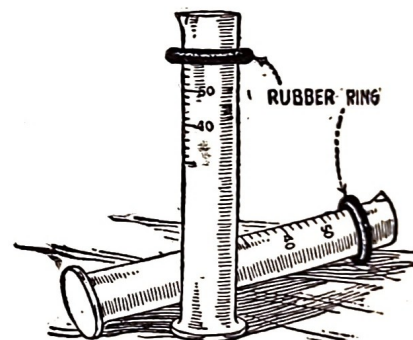
Hero's Fountain



A simple model of that most interesting demonstration apparatus known as Hero's Fountain may be made as shown above. A glass delivery tube, 3 pieces of rubber tubing, 2 glass bulbs and a nozzle are all the apparatus required. Assemble them as shown, placing the parts at the various relative heights indicated. Pour water into the delivery tube until the entire system is full. The water will then flow from the nozzle and if the latter is properly directed, will fall into the delivery tube as shown. The length of flow depends upon the constriction at the nozzle. Some of these fountains have been known to flow for 12 hours without stopping.

—A. A. Blumenfeld.

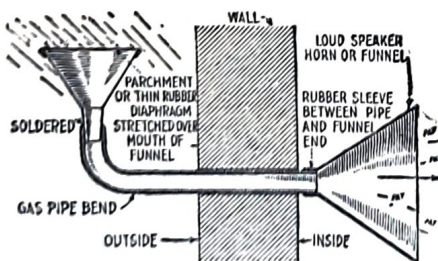
Graduate Protector



If a rubber ring such as used on suction flasks is placed around a graduate as shown above, it will prevent breakage. If the graduate falls on its side, the rubber ring absorbs the shock.

—A. Eidman.

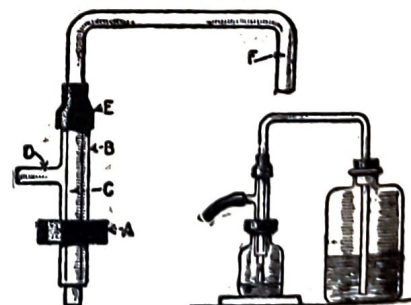
Rain Alarm



A rain alarm that requires no batteries or moving parts is detailed above. Two funnels, a diaphragm and a bent gas pipe are all that are required. The rain falling on the diaphragm produces sounds that are plainly audible at quite a distance from the reproducing funnel. The rubber sleeve facilitates removal.

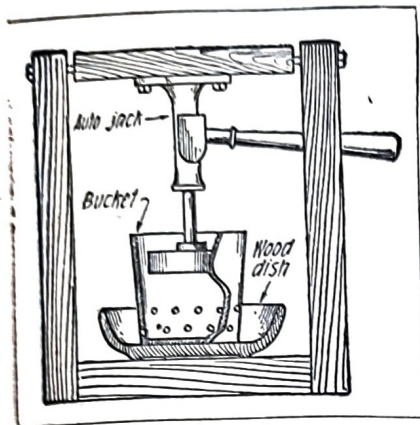
—C. O. Oldroyd, Rep. No. 4433.

Bottle Filler



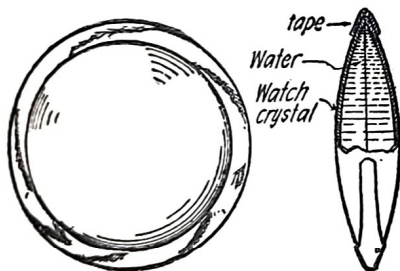
When handling liquids having disagreeable fumes, the above device is useful. Attach D to a suction pump. A partial vacuum is created in the bottle being filled and the liquid from the large bottle passes into the small one through the long bent tube.

Fruit Press



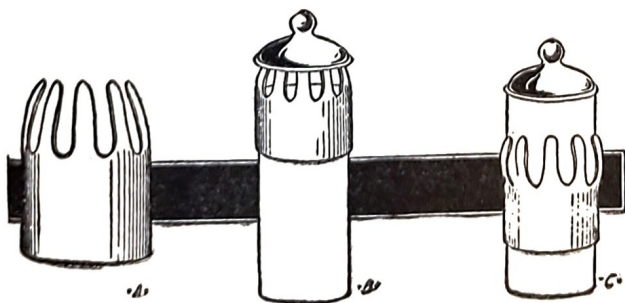
Into a large wood frame constructed as shown above, put a large bucket with two lines of holes drilled around the bottom. Place the fruit to be pressed in the bucket, and on top of it place a circular wooden block, which will fit snugly inside the bucket. Press the fruit by using an automobile jack between the wooden frame and the block on top of the fruit. It is then only necessary to run the jack down, squeezing the fruit through the small holes. For convenience keep a pan beneath the bucket.—Charles H. Carr.

Watch Crystal Lens

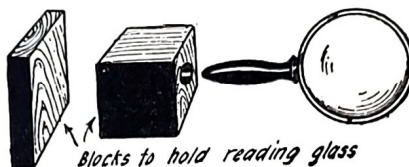
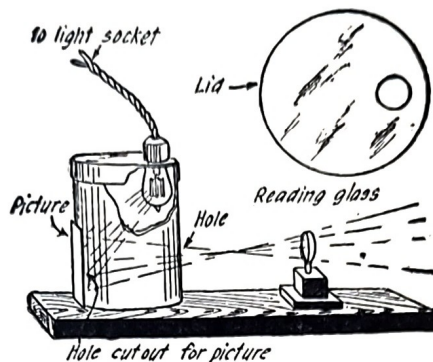


A very serviceable lens can be made by filling two watch glasses, which have been thoroughly waxed and polished, with water, and then sealing the edges. A little grease (vaseline) is smeared carefully around the edges of the glasses, after which they are dipped into the water and put together. Be careful that no air is allowed to remain between them. The lens is then removed, bound with surgeon's adhesive tape, and the edges given a slight coat of vaseline.—Carlyle Weiss.

Nipple Placer

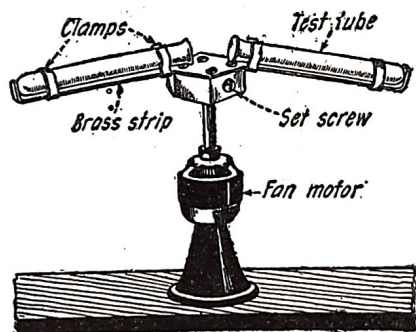


Magic Lantern



If the light from an ordinary 60-watt lamp is caused to fall on a picture, and the rays passed through a reading glass, a satisfactory magic lantern results. The light and picture are fixed in a bucket or can, as shown. The beams then pass through a hole in the front of the can, then through the reading glass. —George W. Morton.

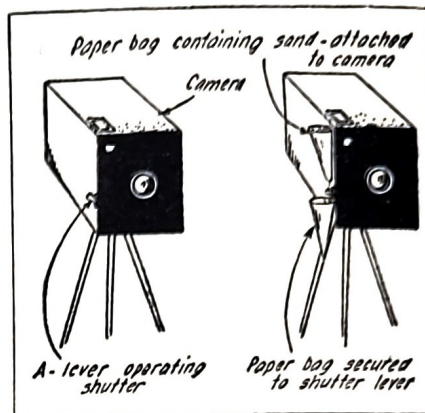
Electrical Centrifuge



By cutting a strip of sheet iron to hold test tubes, as shown above, screwing it tightly to the wooden block, which has a set-screw, and making the whole fast to a fan shaft, an electrical centrifuge is made.

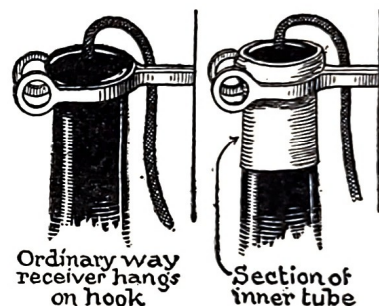
—Dr. E. T. Sonendriker.

Shutter Trip



By fastening a paper cone to the shutter of a camera and then placing a second cone of sand above it, allowing the sand to fall into the first one, a time trip is made —J. Stevenhagen.

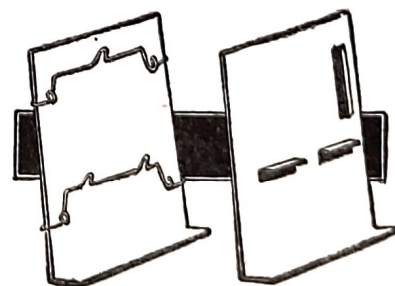
Receiver Silencer



The clatter and mishaps befalling frequently used telephones may be avoided by covering their tops with a short length of inner tube or large rubber hose, as shown above. This precaution will pay for itself many times in broken receiver caps and tempers.

—L. B. Robbins.

Typist's Help



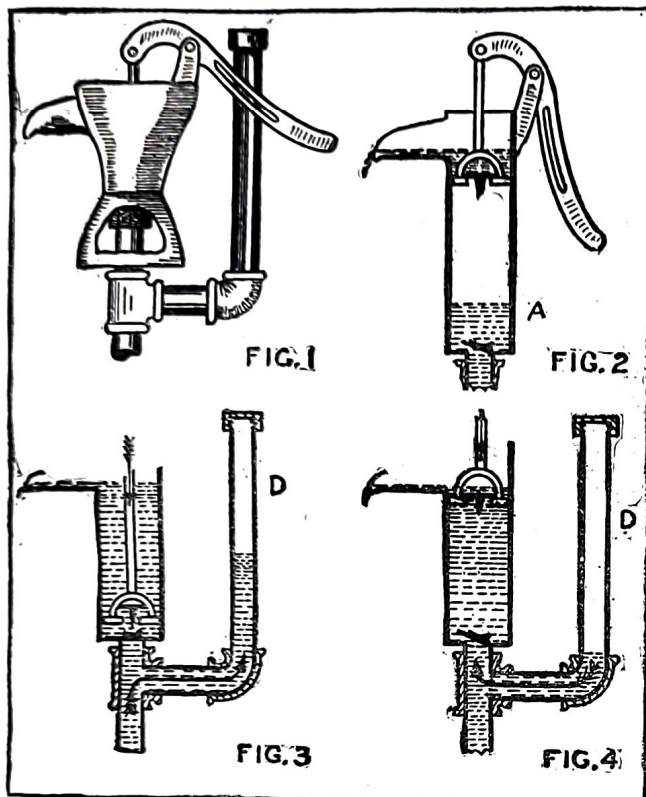
Sheets of tin about 20 inches high, cut and fitted with springs, as shown, set behind a typewriter, make excellent copy holders. On the one to the right, the sheets to be copied are merely set on the protruding lugs, while on the one to the left the stenographer's notebook is placed under the spring wire clips.

—Jacob Schmidt.

By using the metal cone, constructed as shown in the accompanying illustration, the trouble experienced in placing a nipple on the large-mouthed baby bottles, will be greatly reduced. After use, the cone is removed over the body of the bottle as shown.

—Jay G. Hobson.

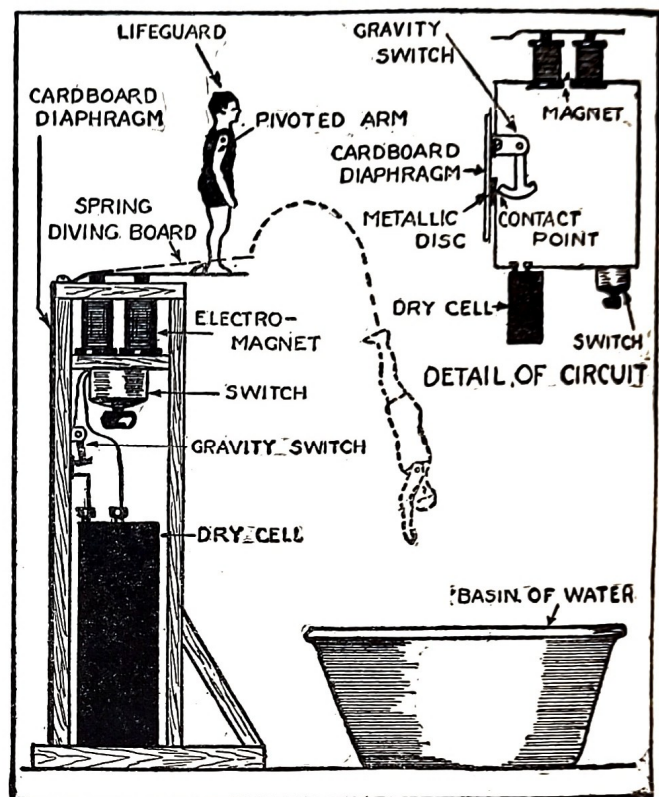
Pump Air Column



The back suction on a pitcher pump may be removed by the addition of an air column below the lower valve, as shown in the above sketch. Instead of the intermittent flow usual with such pumps, the addition of a simple device will produce a steady stream.

—Ben Shilling.

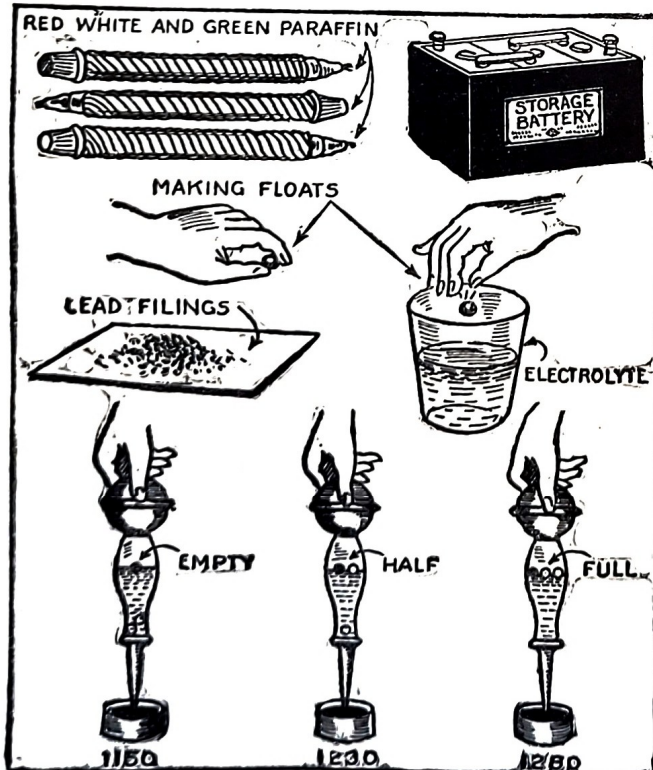
Life Saver



If one yells "help," the cardboard diaphragm in the above toy opens the gravity switch, releasing the magnetic current which holds down the spring diving board, forcing the diver to jump from his perch into the bowl of water as if to the rescue.

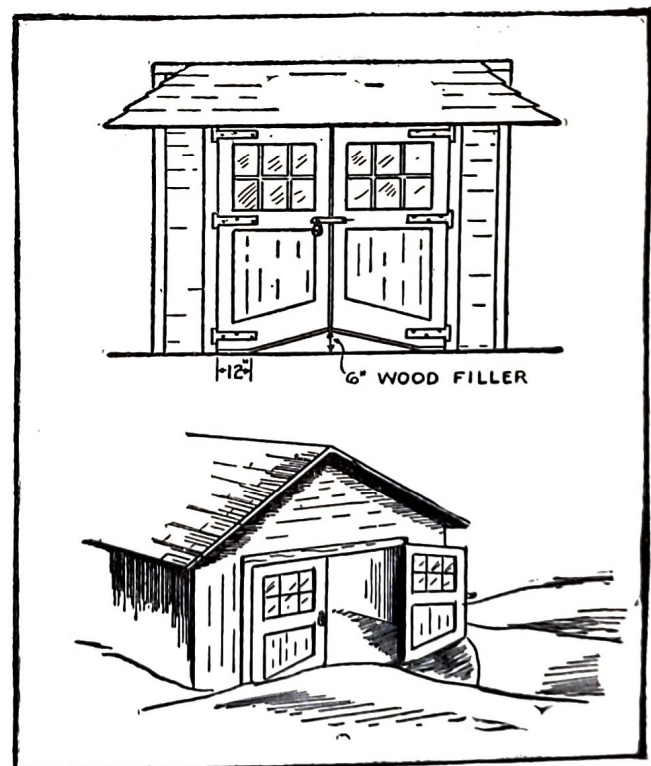
—Chas. D. Tenney.

Novel Hydrometer



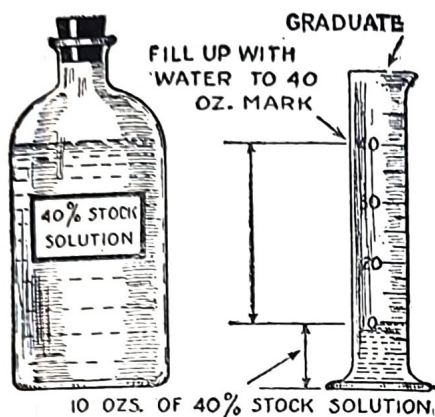
By weighting three balls made of paraffine of different colors with lead filings, so that they float at the charge, half charge, and discharge, specific gravity of storage battery electrolyte, a hydrometer results.—J. T. Graver.

Non-Drag Doors



By placing a triangular piece of wood filler in the center of garage doors and cutting the doors at an angle at the bottom as shown, the annoying drag of the doors on bits of cinders and snow may be obviated.—R. C. Dole.

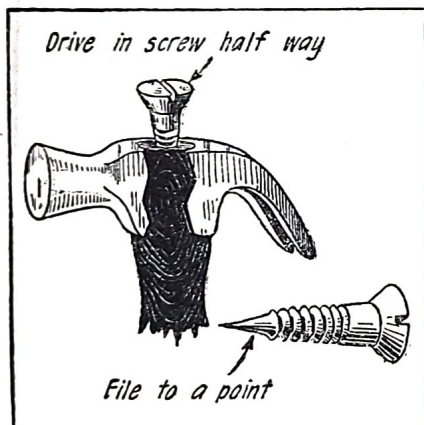
Simplified Solutions



Accurate percentage solutions can be made up quickly from a 40% stock solution. Use as many ounces of the stock as is represented by figure of desired percentage and fill graduate to 40 ounce mark with water as above for 10% solution.

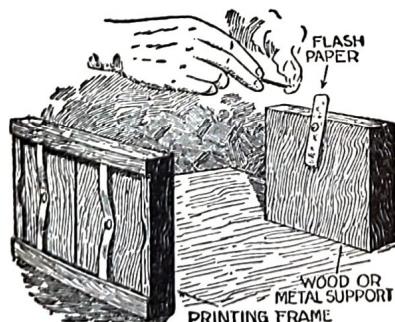
—C. A. Oldroyd, Rep. 4433.

Hammer Head Retainer



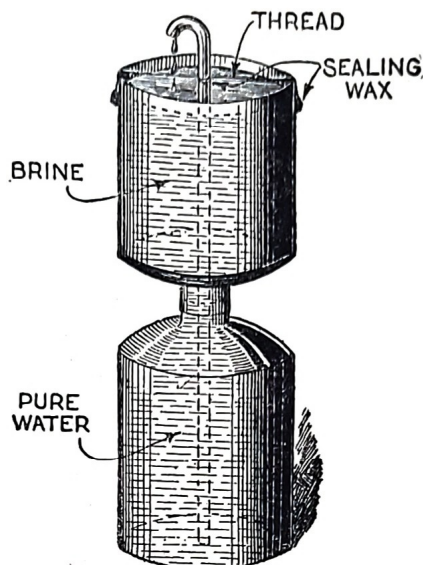
A screw filed to a point and driven in the end of a hammer handle will hold the head firmly in place. —Pan.

Printing



A piece of flashlight paper about 1" x 1/2" placed about a foot away from a printing frame will give ample light for an exposure. Vary the distance according to the density of the negative. —Morris Goldstein, Rep. 1,029.

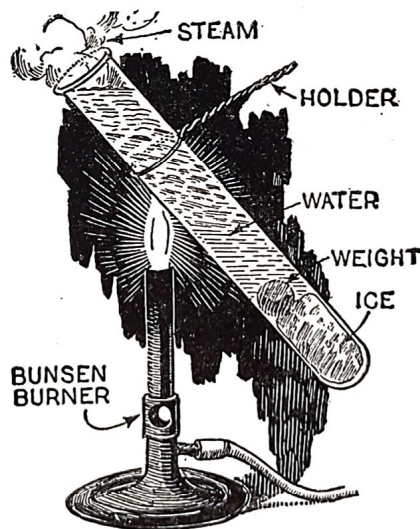
Odd Fountain



Without an explanation, the experiment illustrated above seems to disprove the fact that water cannot run up hill. However, if two containers are joined as shown, a tube bent as illustrated, inserted and the lower jar filled with pure water while strong brine is placed in the upper, the pure water will flow out of the tube due to the greater density of the brine.

—G. H. Waetjer.

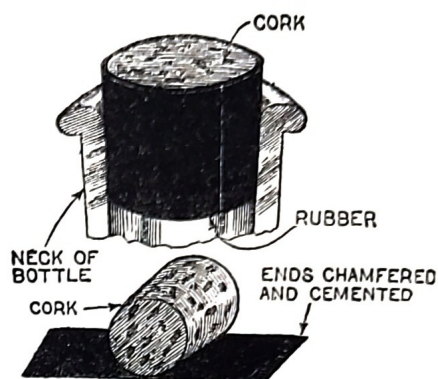
Ice in Boiling Water



A very pretty experiment which illustrates the fact that heated water rises to the top of a container may be made as above. Drop a piece of ice in a test tube and weight it down with a leaden ball. Fill the tube with ice water and hold over a Bunsen burner at a 45° angle. The water will soon boil, but the ice will remain solid. The convection currents in the water have kept the heat away from the ice.

—G. H. Waetjen.

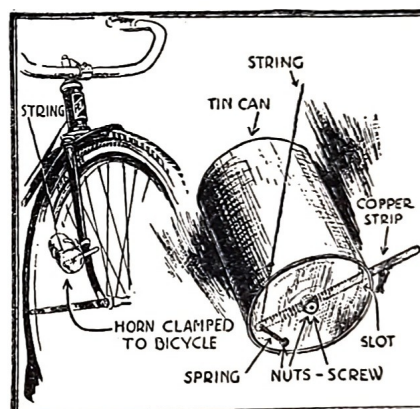
Rubber Stoppers



A substitute rubber stopper may be made from a strip of rubber and a cork as above. Bevel or chamfer the edges of the rubber strip and cement firmly to the cork. A stopper of this nature will hold its place firmly.

—C. A. Oldroyd, Rep. 4433.

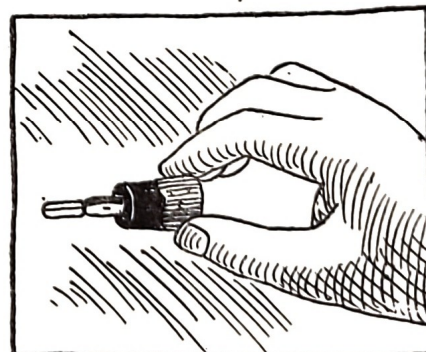
Bicycle Horn



A bicycle horn may be made from a tin can if arranged with a metal strip as shown above. Place the unit so that the strip hits the spokes when the cord is pulled.

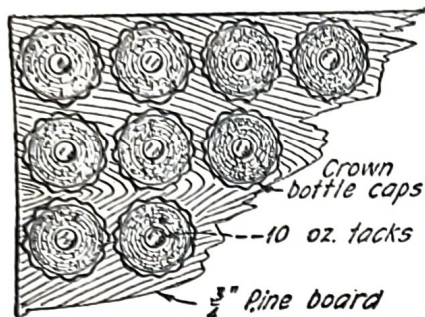
—B. Piopongco, Rep. 12,894.

Ink Dropper



A simple filler for a drafting pen is shown above. A steel pen thrust into a cork is dipped into the ink and then used as a quill.

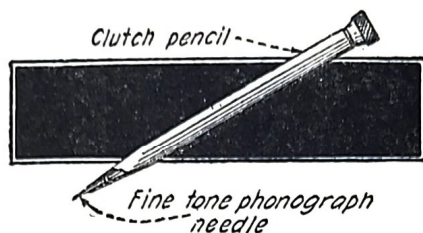
Shoe Scraper



A cheap shoe scraper, much more effective than a fibre or rubber mat, can be made with a few crown bottle caps and 10 oz. tacks as shown in the above illustration. Fasten the base board to the floor.

—W. T. Markowski.

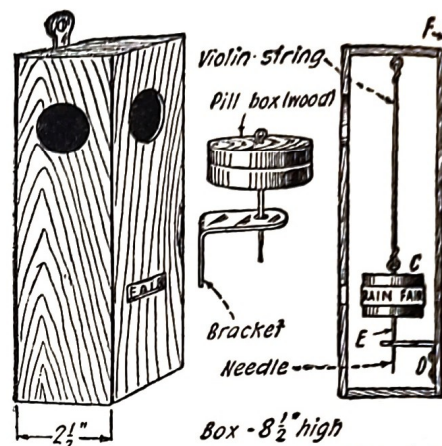
Scratch Awl



In working metals and radio panels a scratch-awl, or stylus, is a necessary part of the workman's equipment. A very handy and serviceable instrument of this type can be made by inserting a phonograph needle in a metal chuck pencil that may be obtained cheaply at any hardware store.

—W. H. Holland.

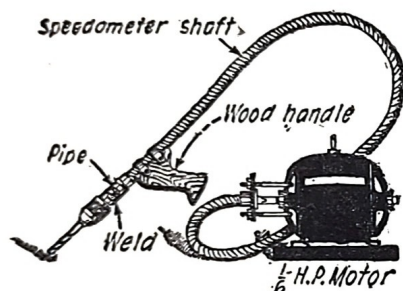
Barometer



A cat-gut violin string fitted with an indicator as shown makes an excellent barometer. To calibrate it, on a dry day, mark "Fair." Then let a drop of water soak the string and mark "Rain."

—Elder Schaffner.

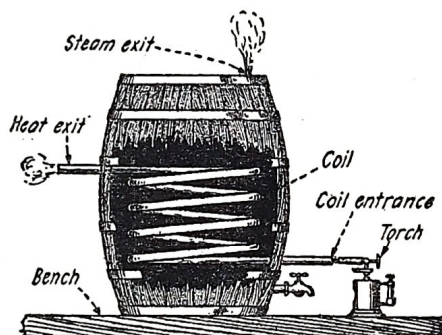
Snake Drill



By using an old speedometer shaft and a cast-off drill chuck, a snake drill may be made that will be serviceable in inaccessible places. The motor shaft is slotted to take the speedometer shaft and the chuck is welded to the other end. The pipe just behind the chuck takes up the thrust.

—Harold Jackson.

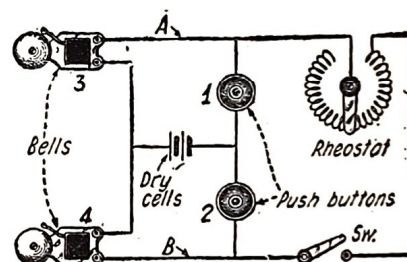
Blow Torch Boiler



A length of one and one-half inch pipe coiled and inserted in a barrel as shown makes a fifty-gallon boiler. If a three-inch nipple about six inches long is fitted over the end of the coil taking the blow torch so that the head of the torch may be inserted into it, better results may be gained. A cock is fitted to the bottom of the barrel for drawing off the water.

—L. M. Jordan.

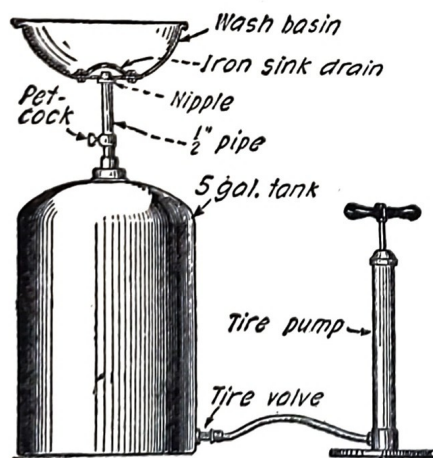
Door Bell Circuit



In the double door bell circuit shown both bells may be rung with either button. The resistance inserted in one of the circuits gives each of the bells a different tone. The switch separates circuits.

—S. S. Peszel.

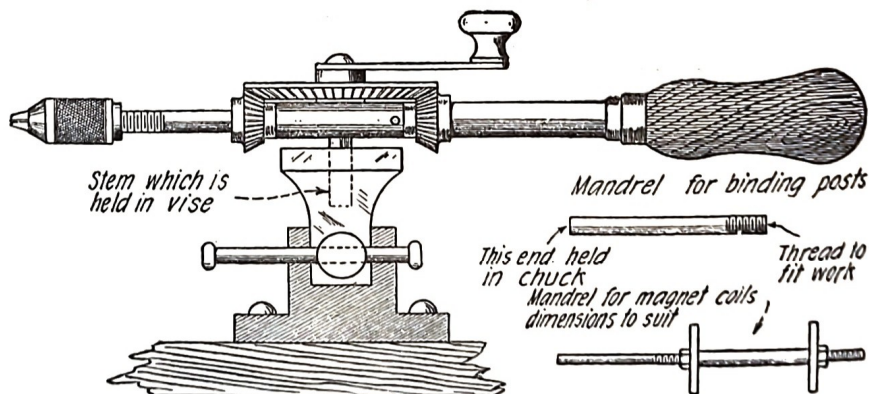
Washbasin Forge



By drilling a hole through the bottom of a discarded wash-basin and covering it with a sink drain and inserting the air lead, a very handy small forge can be constructed. The petcock regulates the flow of air from the tank.

—John F. Pascik.

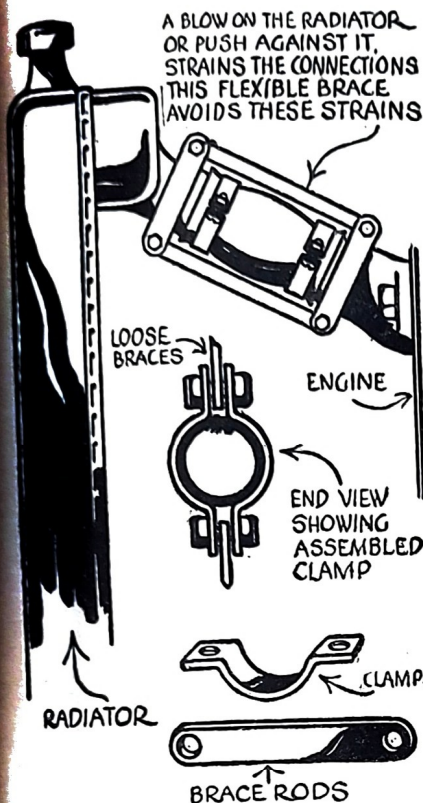
Small Lathe from Breast Drill



If the small handle, opposite the large gear wheel on a breast drill, is removed and the stem is supported in a vise, a small lathe is the result. A motor may be attached to the large gear for running it. This lathe will find many uses in winding coils, dressing round work and polishing. In winding coils with its aid, a mandrel, such as the one shown should be constructed. In polishing or finishing binding posts, another is used. A couple of pieces of copper facing the vise jaws will save the drill spindle.

—Harry Lubcke.

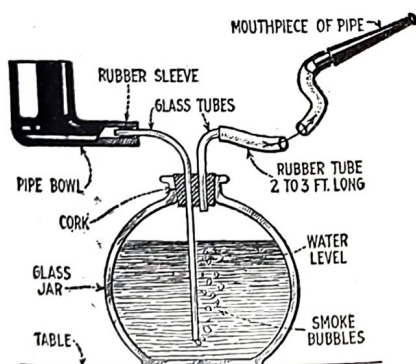
Hose Kink



An elastic brace to prevent the straining of the hose connections leading to the radiator of a car is simple to construct. It will prevent the radiator from working loose by linking it with the engine.

—G. A. Luers.

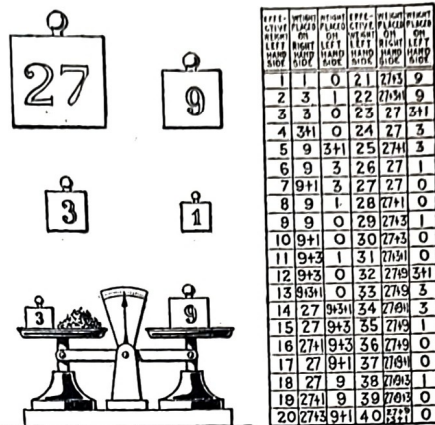
Hookah



A smoker's pipe that is free from nicotine can be easily made as shown above. The bowl and stem of an ordinary pipe are separated and used as illustrated. When tobacco is smoked in this way, the fumes are drawn through water and most of the nicotine removed. The result is a cool, sweet smoke that cannot be obtained in any other way. Some addicts of this type of pipe say that a very minute quantity of perfume placed in the water is desirable.

—C. A. Oldroyd, Rep. 4433.

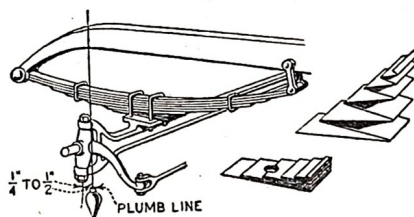
Weight Combination



It is possible to obtain a great number of different combinations if we have on hand a set of weights such as those shown above, namely one, three, nine and twenty-seven grams, ounces or pounds as the case may be. Any weight from one to forty pounds can be determined with these four standards. They are variously arranged on opposite pans of the balance as shown in the illustration, following the chart given at the right above. Obviously in the illustration, six ounces of material on the scale will bring about a balance.

—A. A. Blumenfeld.

Auto Spring Wedge



When an automobile spring has to be wedged upward as shown in the above diagram in order to restore caster or in other words keep the axle at the required angle, a solid metal wedge is not always obtainable. In lieu of this, a wedge can be built up of thin sheets of iron cut and bent as shown. The edges are then hammered together, whereupon the finished product will give just as good results as will a solid wedge.

—O. Justiss.

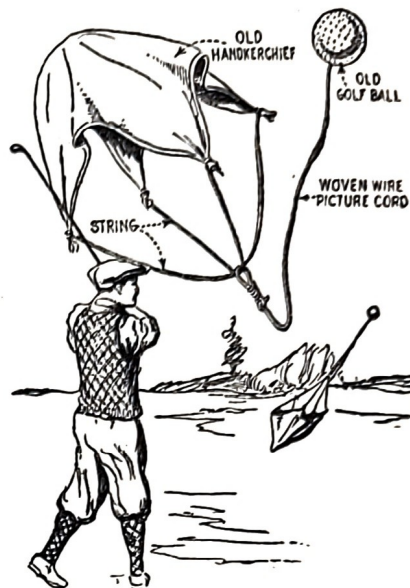
Unique Violin



A violin that will produce quite a great amount of volume and with which the sound can be sent in any desired direction is illustrated above. A standard violin neck is used while the body is a block of wood through which a hole is drilled to the end of the horn. A metallic bridge is soldered to the metal diaphragm, D. The diaphragm is soldered to the horn, E. If carefully made, this instrument will be very satisfactory.

—K. A. Sugh, Rep. No. 13,229.

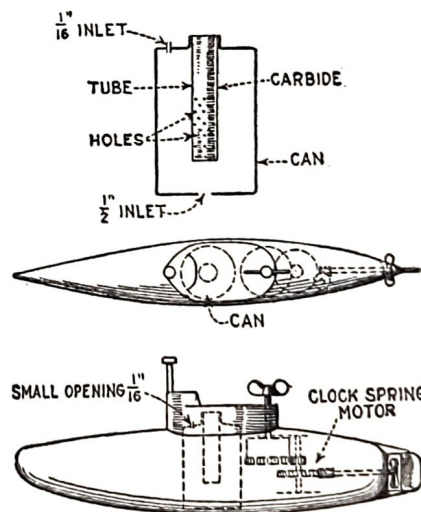
Parachute Golf Ball



A captive golf ball such as the one shown above enables one to practice in a much smaller space than would be possible if a regular ball were used. Drill a hole through an old golf ball, pass several feet of picture cord through the hole and fasten a home-made parachute to the other end as shown. A knot in the cord next to the ball prevents the latter from coming off.

—F. S. Root.

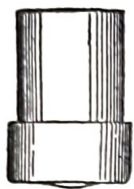
Toy Submarine



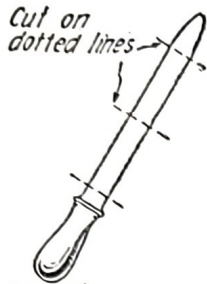
A submarine that will really submerge can be made from a few pieces of scrap tin and wire and a clock spring motor as shown above. The can illustrated must be rather strong so as to withstand pressure. Fill tube with calcium carbide or two parts of citric acid and one part sodium bicarbonate. Fit a dry, soft pine plug loosely into the small hole in the top of the can, place the boat in the water and it will sink only to rise soon to the top again.

—Fred C. Jones.

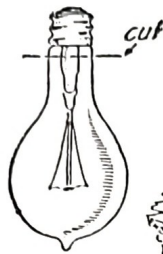
Home-Made Laboratory Equipment



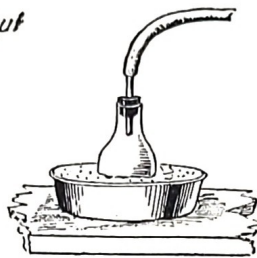
Iron
Crucible



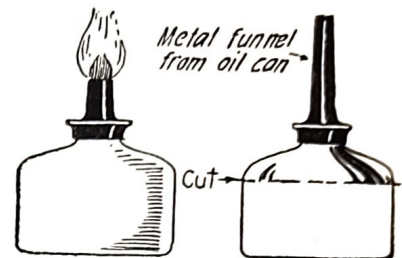
Glass tubes from
medicine dropper



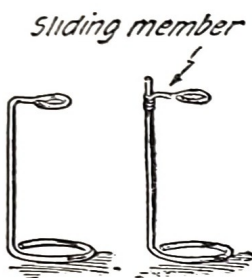
Flask from
light bulb



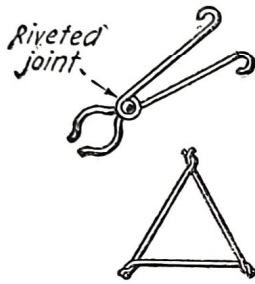
Sand bath for
heating flask



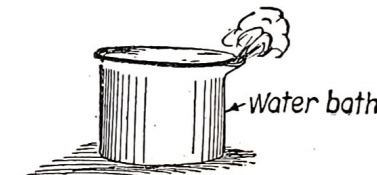
Alcohol lamp from
oil can



Ring stands bent
from wire



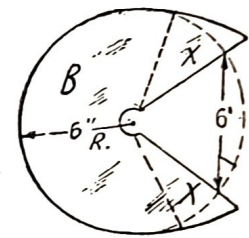
Tongs and triangle
bent from wire



Watch crystal
evaporator



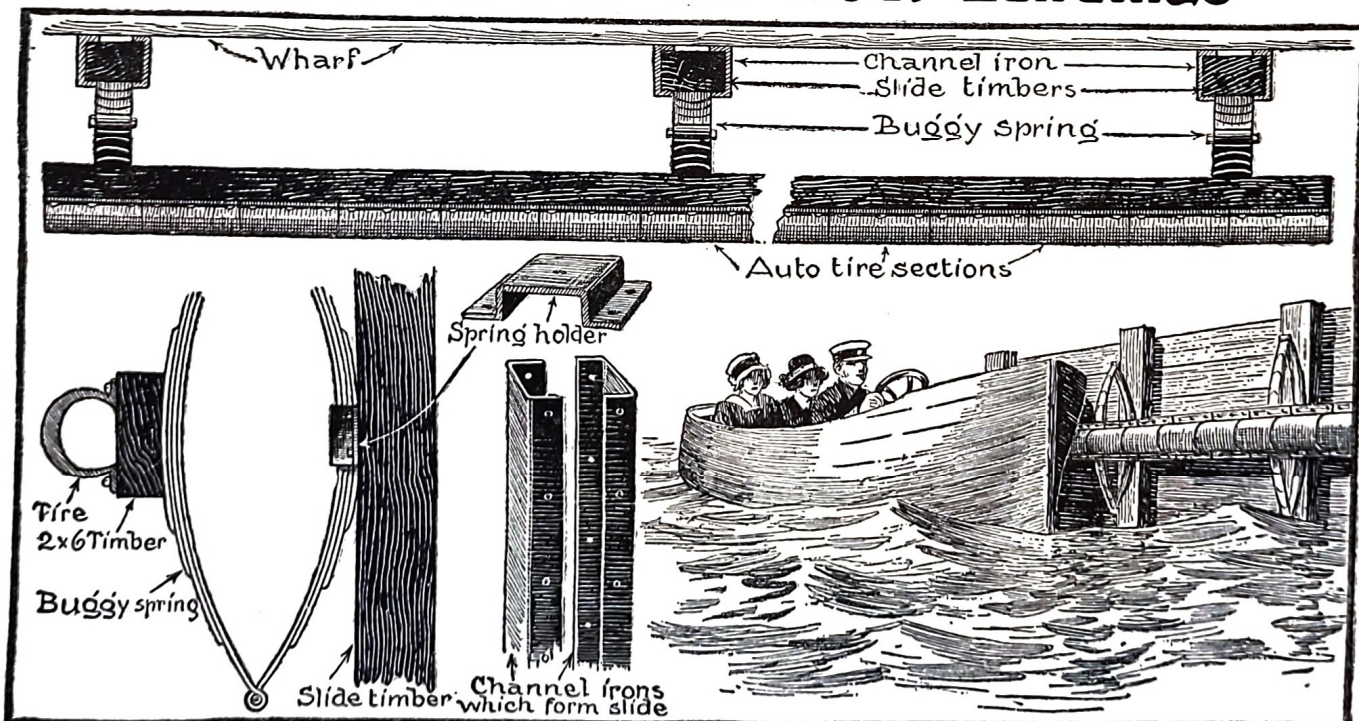
Oil paper filter-paper
holder or funnel



Many experimenters living away from the larger cities encounter much trouble in getting the kind of apparatus necessary for their experiments at a reasonable cost. Above are shown some of the ways the experimenter may manufacture his own apparatus from materials found at home. An iron crucible is made from a short length of pipe and a pipe

cap. Short lengths of glass tubing may be made from ink droppers. A serviceable flask is made from a large light globe. An alcohol lamp and funnel is made from an oil can. Ring stands, triangles and tongs are made from stiff wire. Filter paper holder is made from waxed paper.—Charles D. Tenney.

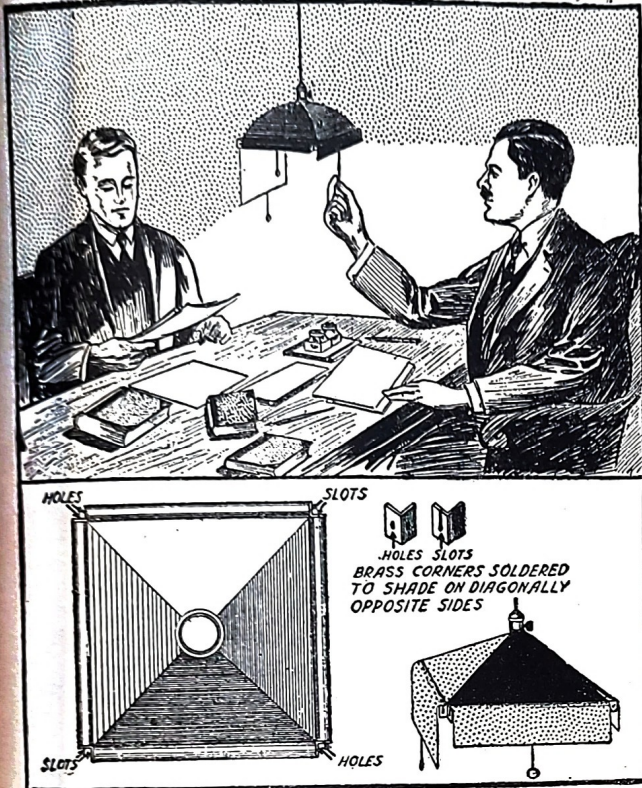
Spring Bumper for Boat Landings



The owner of a small boat can provide a means of docking his craft at the home wharf, which will break the shock of landing and save wear and tear on both the boat and the dock. The drawings show a timber padded with auto tire sections, bolted to three light automobile or buggy springs. Each spring, in turn, is bolted to an upright timber which slides in a ver-

tical groove formed by two angle irons which are secured to the dock. The timber floats on or above the surface of the water, depending on the buoyancy of the upright pieces, and thus takes care of the rise and fall of the tide automatically. The tire sections prevent chafing and the springs take up the brunt of the landing impact.—L. B. Robbins.

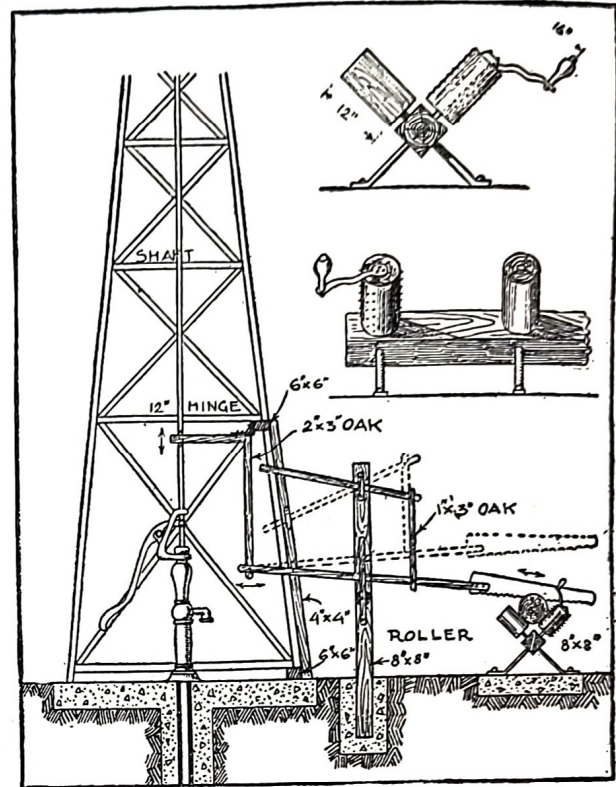
Lamp Shade Kink



Where several persons are forced to use the same light each may have an individual shade by soldering small angles, cut as shown, to the corners of a square shade and installing curtains on rollers on each side of the large shade.

—V. Giomei, Reporter No. 2997.

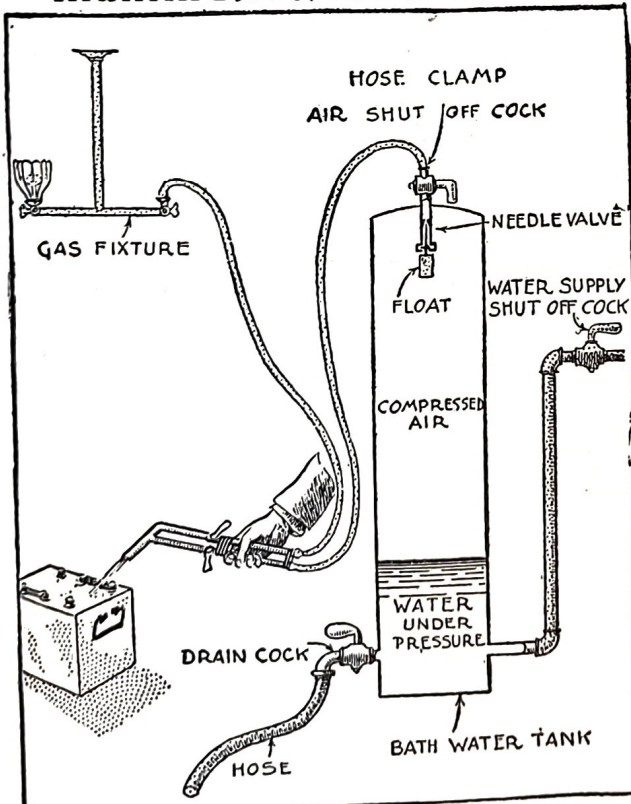
Wind Power Saw



By attaching a system of levers, such as the one shown above, to a windmill and equipping the saw buck with rollers, an exceptionally handy wind-power saw is produced. A roller on the auxiliary post keeps the saw from falling to the ground.

—H. H. Siegle.

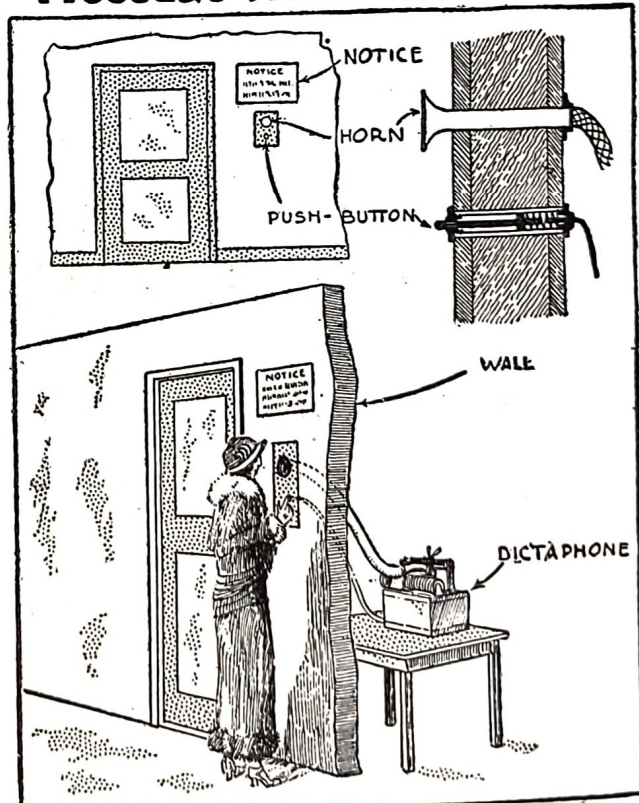
Illuminating Gas Torch



When the city water rises in the tank shown in the sketch air within is compressed so that, when used in connection with ordinary illuminating gas, a very hot flame results. The float at the top prevents the water running into the air feed pipe.

—J. M. Galbraith.

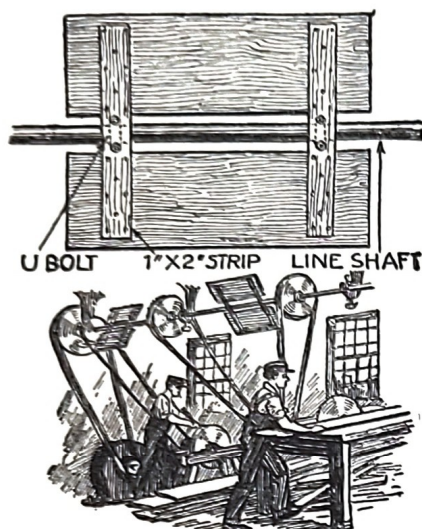
Message-taker for Office



In offices whose occupants are frequently out, the above arrangement, making use of little more than a regular dictaphone, will be found exceptionally handy. The mouth-piece of the instrument extends through the wall with the starting and stopping button beneath it. The directions are on a placard above.

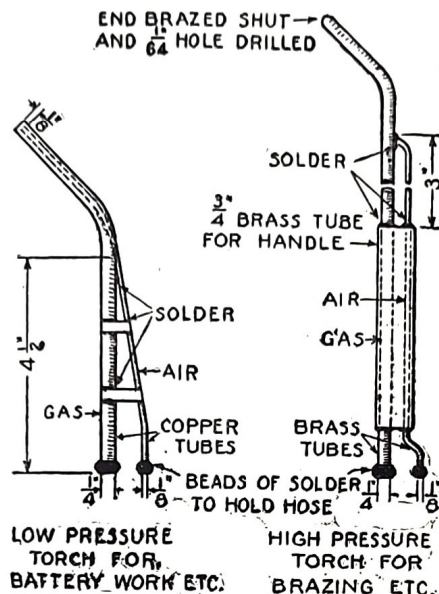
—H. H. Siegle.

Shop Fan



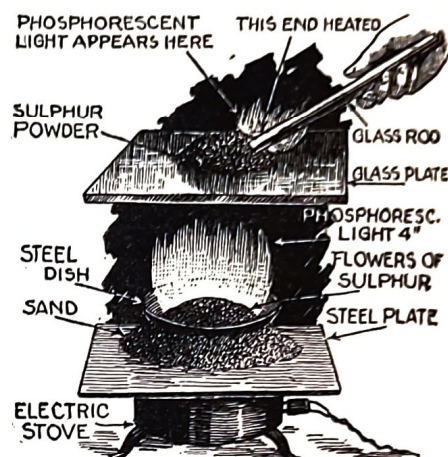
A fan for use in machine shops may be quickly and easily made as shown above. It is to be clamped on a line shaft and will give excellent results with a very low power consumption.
—E. L. Edwards.

Torches



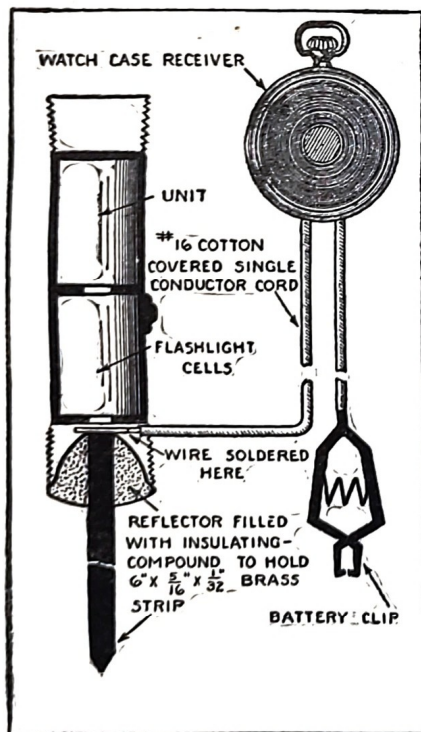
Torches for high and low pressure use may be made as shown above at the right and left respectively with brass or copper tubing. Rubber tubes lead to the tanks.
—K. B. Thompson.

Phosphorescent Light



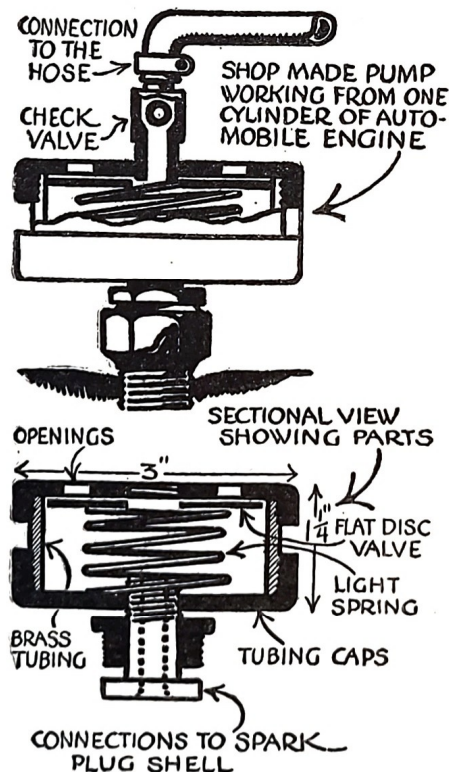
Two interesting chemical experiments in the production of phosphorescence are illustrated above. Sulphur, when heated by any of the two methods illustrated, produces a very weird luminous effect. For all experiments in phosphorescence the room should be quite dark.
—C. A. Oldroyd.

Test Set



For use on all kinds of electrical apparatus and radio sets, the above illustrated tester gives excellent results. Two flashlight cells in a reconstructed case furnish power. The watch case receiver is the detecting element.
—W. B. Clark.

Tire Pump



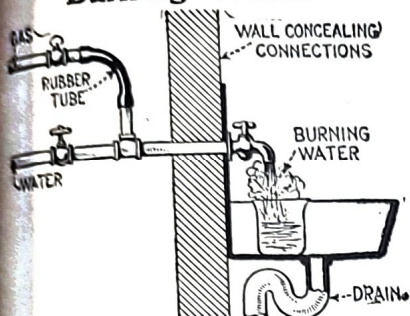
The simple tire pump illustrated above is attached to a spark plug shell. The shell is screwed into one cylinder in place of the plug and the engine operated when a tire is to be inflated.
—G. A. Luers.

Train Speed



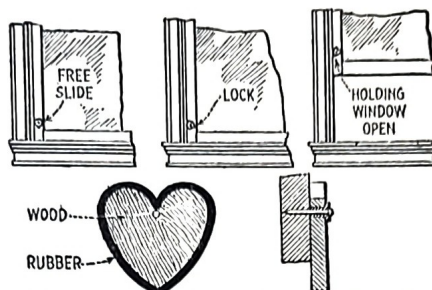
When traveling on a railroad train, one often wishes to know just how fast he is traveling. Here is a method that is much quicker than timing the distance between mile posts and which is of use during day or night. Merely count the number of clicks heard as the wheels of the train pass from one rail to the next in 20.4 seconds. This number will be the speed of the train in miles per hour.—Elliot R. Weyer.

Burning Water



By connecting a gas and water pipe together and allowing both to issue from a faucet as above, the gas can be ignited with a match giving the effect of water burning. This is a good window display.—Carlyle Weiss.

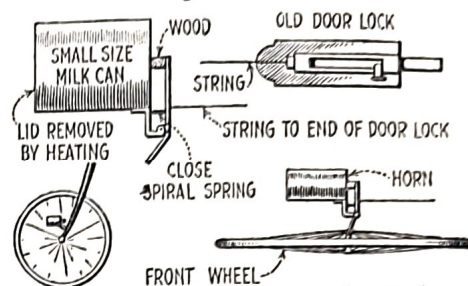
Window Latch



A heart shaped block of wood with a strip of rubber secured to the edge as above, makes an excellent window latch for holding the window closed or open as illustrated. The block is pivoted on a nail as shown.

—L. D. Starcher.

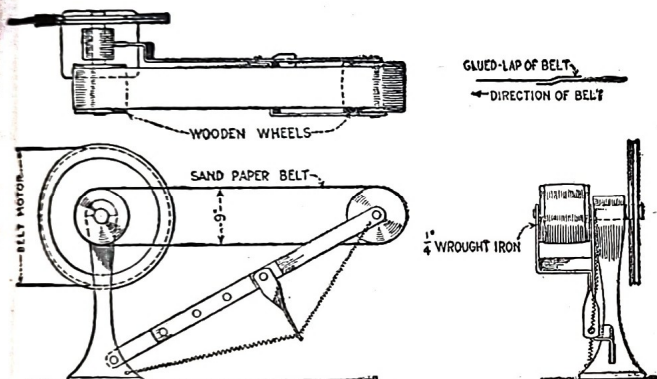
Bicycle Horn



A siren for a bicycle can be made from an old tin can with the attachment shown. The door bolt or door lock shown is for the purpose of holding the striking element away from the can or by releasing it, the siren is made to operate. It is actuated by the spokes striking the lever.

—Aurelio Rivera.

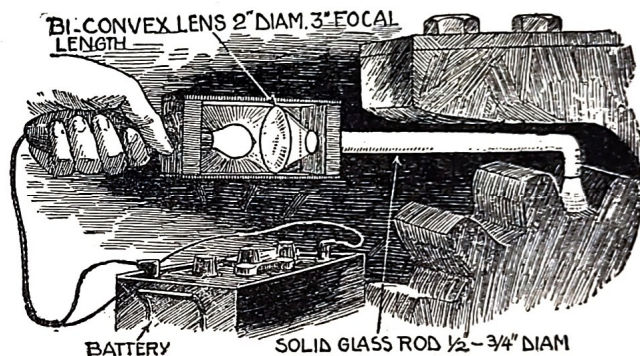
Sanding Belt



A belt of sandpaper is very satisfactory for smoothing off flat objects and one can be readily attached to a motor-driven emery wheel by making up the bracket illustrated in detail above. The belt of sandpaper runs over two large pulleys which can be turned off on a lathe or cut from a wooden cylinder 4 inches in diameter.

—William White.

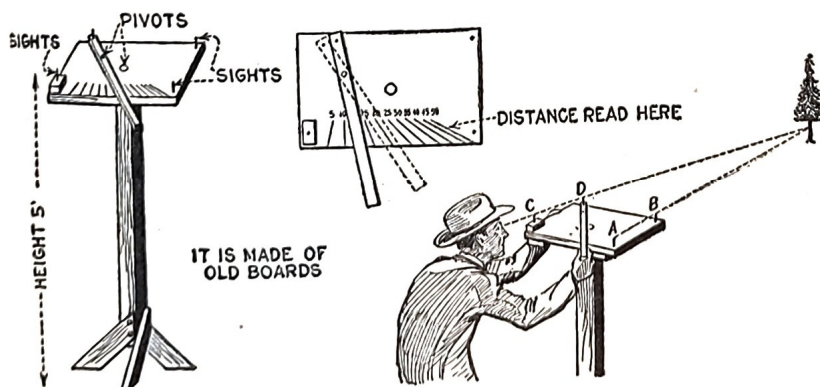
Lighting Inaccessible Parts



If a beam of light enters the end of a solid glass rod, it will follow that rod, even though it be bent. This behavior can be employed for lighting inaccessible parts by means of the arrangement shown above. A source of light is focused on the end of a bent glass rod through a lens of the size shown. A quartz rod is ideal.

—C. A. Oldroyd, Rep. No. 4433.

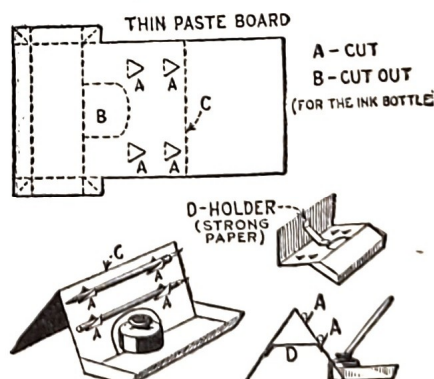
Distance Gauge



If a "distograph" is made up as detailed above and calibrated by actual measurement, it can be used for measuring distances directly. Sight on the object along the two pins at the edge of the board and then holding the board steady, move the pivoted rod and sight along points C and D. The distance will then be indicated on the scale.

—Francis Boyd.

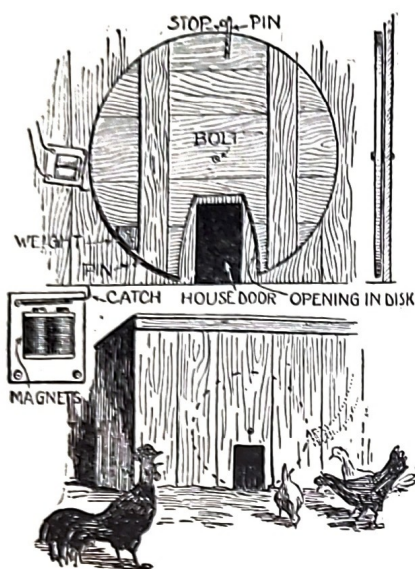
Ink Stands



A handy ink and pen stand can be cut from a sheet of fairly heavy cardboard by following the details given above. After being bent to shape, it is held with paste or glue and the bracket shown.

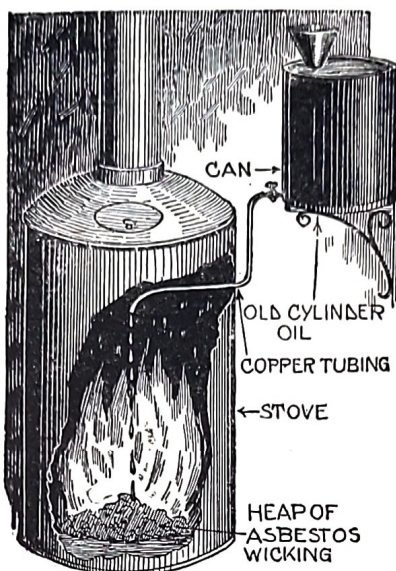
—Hubert Slouka, Rep. No. 7110.

Coop Lock



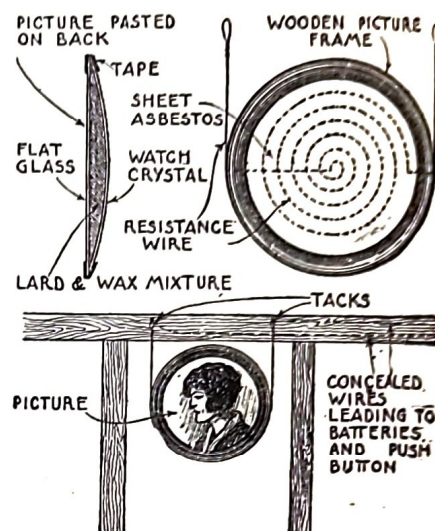
The head of a barrel to which a weight is attached, an electro-magnet, the armature of which is equipped with a hook and a bolt, make an excellent automatically opening chicken coop if they are worked together, as shown in the above sketch. The weight rotates the door to the open position, as soon as the electromagnet is energized, releasing the catch. —L. B. Robbins.

Waste Oil Burner



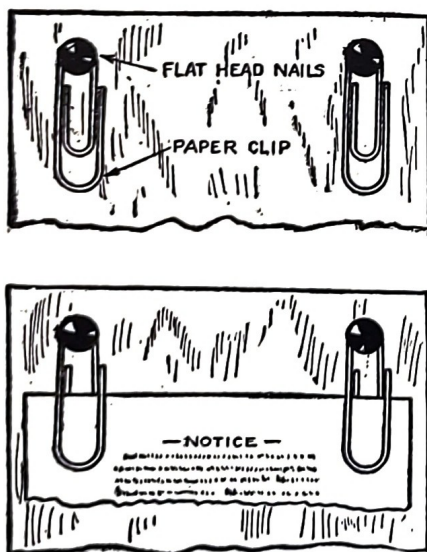
Waste oil may be burned with advantage through the method depicted above. A heap of asbestos wicking is thrown on the grates. The oil container is placed above the stove, and a small pipe carries the oil into the top of the stove, allowing it to drip on the wicking. The pet-cock controls the rate of flow. —Leslie J. Smith.

Spirit Picture



A photograph or view is pasted to a piece of thin circular glass. Over this is placed a four inch watch crystal, and the space between them is filled with a mixture of lard and soft white wax. The two are then taped together. On the back of the rear glass a coil of fine German silver resistance wire is wound and terminated in two loops. A current passed through the wire heats and melts the wax, making the picture visible. Upon cooling, the picture again disappears. This is a good parlor stunt. —Chas. D. Tenney.

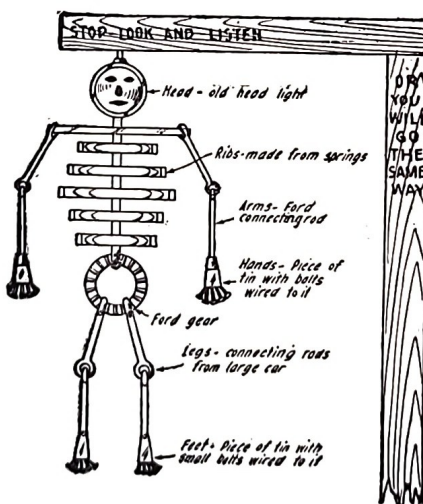
Clip Kink



Where a great many notices are to be posted on bulletin boards, the trick illustrated above will come in exceptionally handy. Two ordinary paper clips are held to the board by flat-headed nails or large thumb tacks. The notice is then simply slipped into the clips.

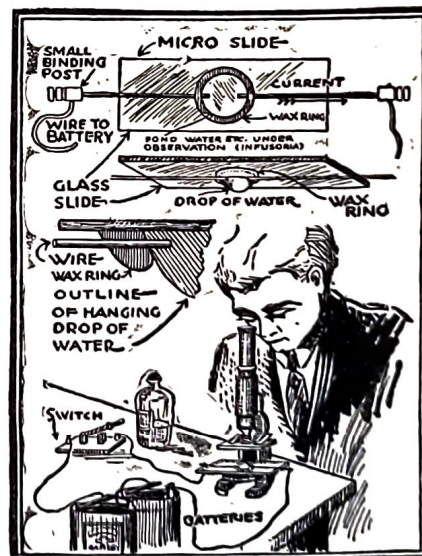
—Wilson Walters.

Warning



One of the most novel methods of calling the attention of passing motorists to dangerous grade crossings, cross-roads or dangerous curves is a sign such as the one shown in the above illustration constructed from old automobile parts. It very eloquently conveys a message, which all the signs made of words known to man would never "put across." —Lyman Mason.

Microscope Kink



In observing the infusoria of water, the small bodies many times pass out of the range of observation. The two wires leading a current into the water, and attached to a small battery, may be used to electrocute them at the proper moment, thus making observation much easier. —C. A. Oldroyd.

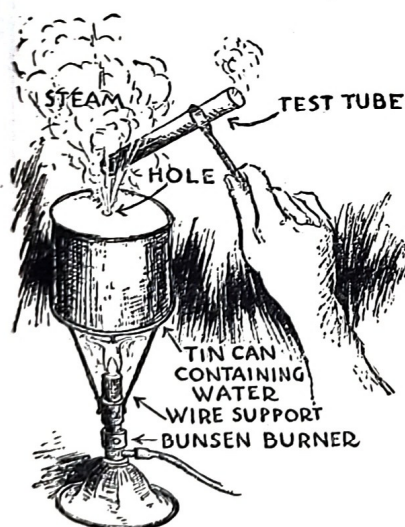
Reminder



A strip of white paper placed around the neck of a bottle with the ends pasted together so that the resulting band can be turned, serves as a reminder of the exact hour when medicine is to be taken if it is marked with the various hours as shown above. An arrow is to be painted on the neck of the bottle. When one dose is taken the band is turned so that the arrow points to the next hour at which the dose is to be repeated.

—K. B. Murray.

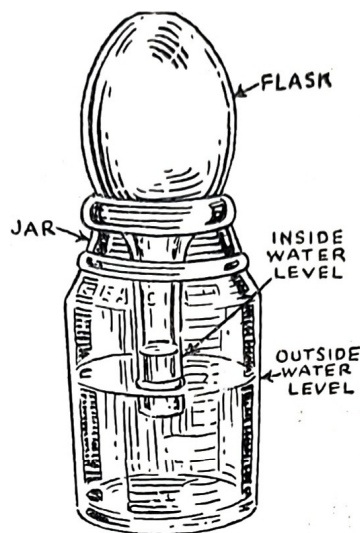
Test Tube Heater



When materials in a test tube have to be carefully heated, the device illustrated above comes in very handy. A small tin can is fitted with a wire support and held above a Bunsen burner. Water is poured into the tin can and the cover, with a hole punched therein, placed in position. Heating the water soon evolves steam which in turn may be used to heat the test tube.

—Robert Rogers, Reporter No. 11,229.

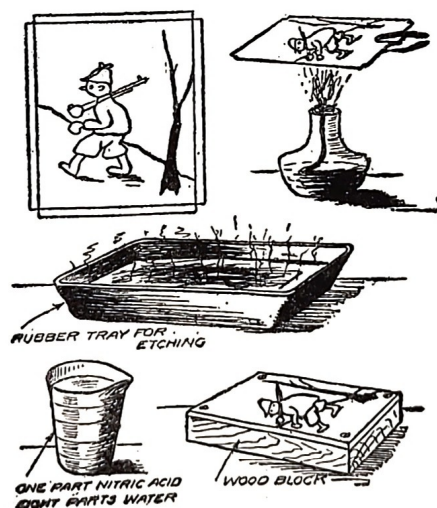
Barometer



One of the simplest weather forecasters is the water barometer. A simple one may be made as shown above. A flask of any available size is inverted in a jar which is half full of water. It will be found that the water will rise or fall in the neck of the flask in accordance with atmospheric pressure. A rise indicates fair weather, while a fall means a change.

—S. Leonard Bastin.

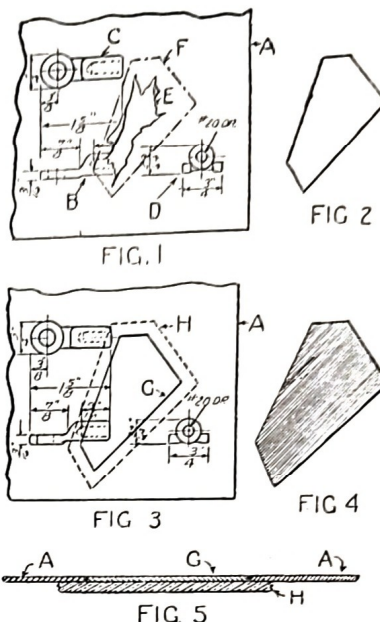
Zinc Cuts



To make your own zinc cuts, draw the required picture on a sheet of zinc with printer's ink mixed with oil of wintergreen. Cover surface with powdered resin and fuse over flame. The sheet zinc is then etched in a bath of one part nitric acid to eight parts of water contained in a rubber tray. The zinc plate is then carefully washed and may be mounted on a wooden block ready for use in a press.

—George J. Gould.

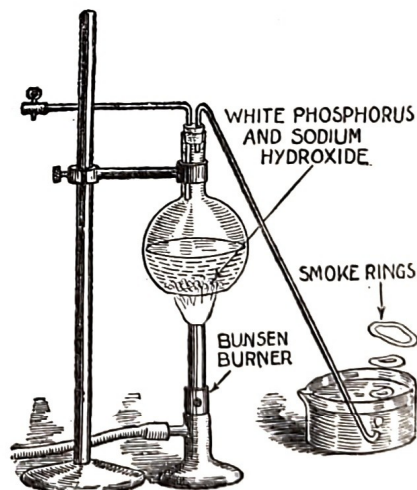
Restoring Tracings



When a tracing is mutilated as shown in Fig. 1, it may be restored. The tear is at E. A second sheet of tracing paper is placed beneath the drawing and a section, F, is cut from both cloths, obtaining a strip from the new sheet which will fit into the removed portion of A. The new piece is placed and fastened with an overlapping strip and collodion. In Fig. 5, A is the original sheet, G the replacement, and H the binding strip. The removed portion is redrawn on the new piece.

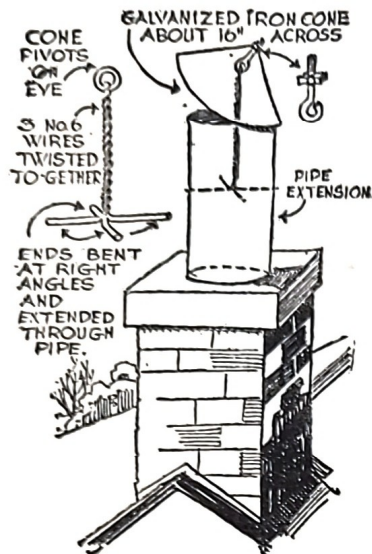
—Gustavo Gallopin.

Smoke Rings



By setting up the apparatus as shown above and boiling the solution, phosphine will be evolved and when the bubbles reach the surface of the water in the beaker, they will spontaneously catch fire and form smoke rings. Before starting experiment, it is advisable to pass illuminating gas through the flask to remove all the oxygen that may be contained therein. The second tube shown is for this purpose.

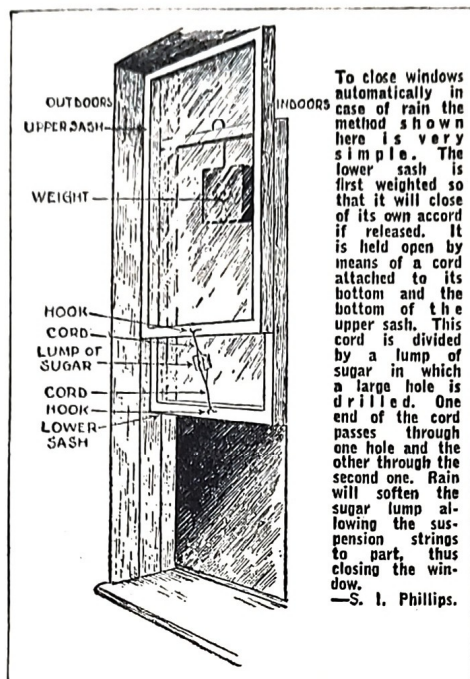
Chimney Kink



When a chimney is too short to produce sufficient draft the installation of the cone shown above supported by an eye and three suspension wires fastened in a short length of extension chimney pipe will bring the draft up to normal. The supporting wires should be at least No. 6 or larger.

—Dale R. Van Horn.

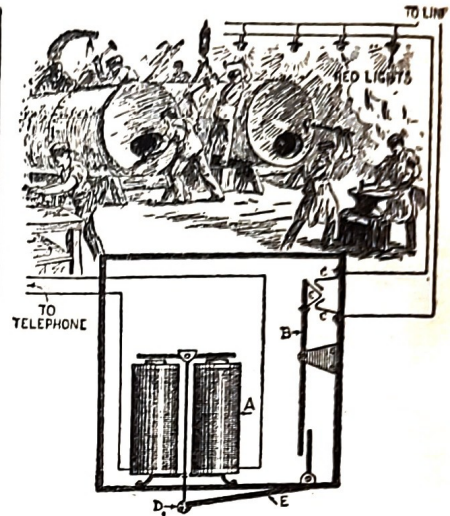
Window Closer



To close windows automatically in case of rain the method shown here is very simple. The lower sash is first weighted so that it will close of its own accord if released. It is held open by means of a cord attached to its bottom and the bottom of the upper sash. This cord is divided by a lump of sugar in which a large hole is drilled. One end of the cord passes through one hole and the other through the second one. Rain will soften the sugar lump allowing the suspension strings to part, thus closing the window.

—S. I. Phillips.

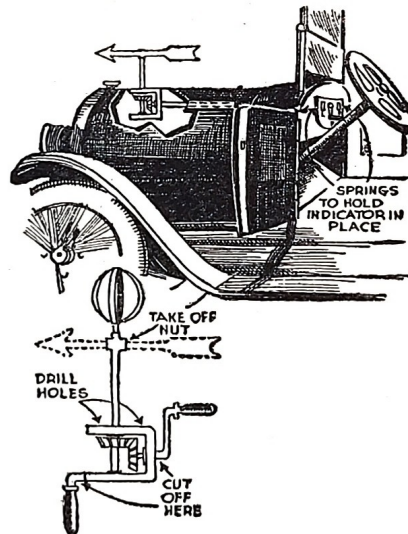
Telephone Signal



In machine and boiler shops where there is a great deal of noise a very convenient method for calling attention to the ringing of the telephone is shown above. The attachment shown in the bottom of the illustration is placed in series with the telephone ringer and flashes red lights in the shop. When the bell rings the arm E drops out of the notch in the clapper and falls against B which in turn closes the light circuit.

—H. L. Anderson.

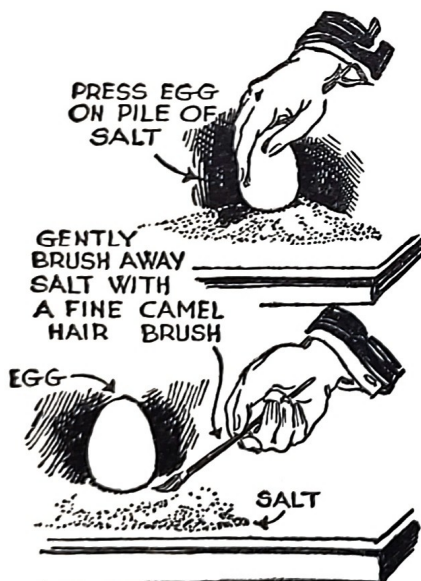
Turn Pointer



A very simple direction indicator for motorists that can be made from spare parts found around the ordinary shop is illustrated above. The gear part of the device may be taken from an old egg-beater or other similar kitchen apparatus. The beater is cut as indicated and placed under the fore part of the hood. The beater blades are cut off and an arrow substituted in their place. An extension arm is placed on the operating gear and is carried back to the dash board. A handle is placed there for the operator's use. In congested districts and heavy traffic this little device will be found of exceptional merit in saving the driver time and the wrath of traffic policemen.

—W. S. Hendren.

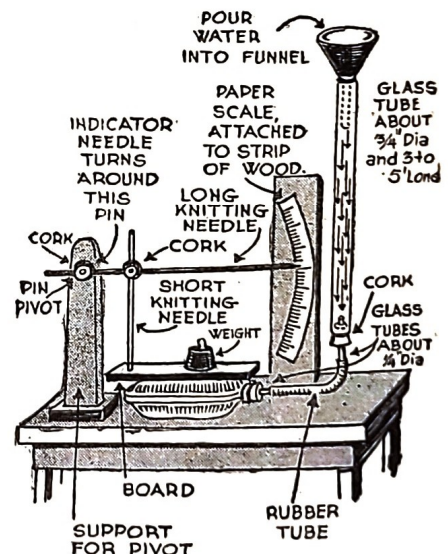
Balancing Egg



A very entertaining stunt for the dinner table is shown above. An egg is balanced in the center of a plate and stands perfectly. The method of performing the stunt is simple. Place a half teaspoon of salt in the center of the plate and press the egg lightly in the center of the salt. Then with the aid of a fine camel's hair brush slowly remove the salt from around the egg. At the completion of this operation the egg will seem to stand by itself.

—C. A. Oldroyd.

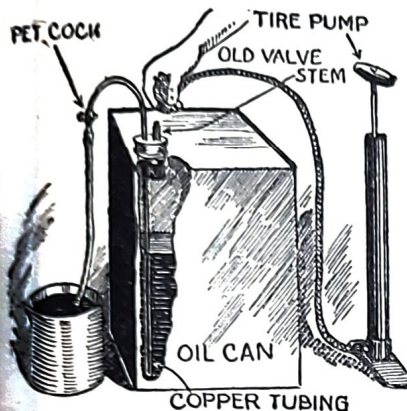
Hydraulic Press



An extremely interesting model of the hydraulic press can be made as shown in the above illustration. The only pieces of apparatus needed are an old hot water bottle, some corks and a few bits of glass tubing. They are assembled as shown in the illustration. The levers and the indicating scale are for measuring the distance through which the weight is raised. To operate the device and raise the weight it is only necessary to pour water in the funnel at the top of the head tube. A fifty-pound weight can be raised.

—C. A. Oldroyd.

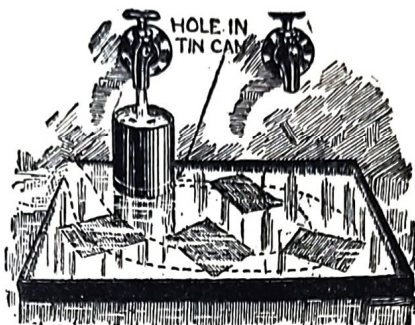
Liquid Dispenser



Liquids in large cans can be readily dispensed by using the system outlined above. Air pressure developed by the tire pump forces the liquid out. The flow may be stopped when desired by the pet cock.

—L. J. Smith.

Print Washer



A very handy print washer for the amateur photographer can be made as shown above. A hole is punched near the bottom of the tin can which is then placed in the washing tray. Water is allowed to run into the can and to escape over one edge of the tray. The hole in the can creates a current of water that thoroughly washes the prints.

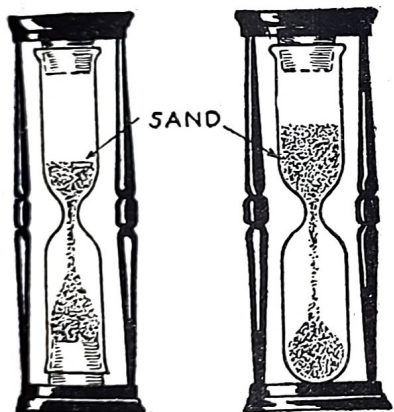
Tire Tool



PACKING NEEDLE WITH EYE FILED AS SHOWN
Rubber bands will repair bicycle tire punctures. Coat the bands with rubber cement, insert in hole, remove tool. Cut bands flush with tire when dry.

—Milton White.

Time Glass



The time glass illustrated above will serve many purposes. It consists of either a glass tube or test tube, heated and drawn out as shown. The amount of sand is determined by experiment.

—F. R. Newton.

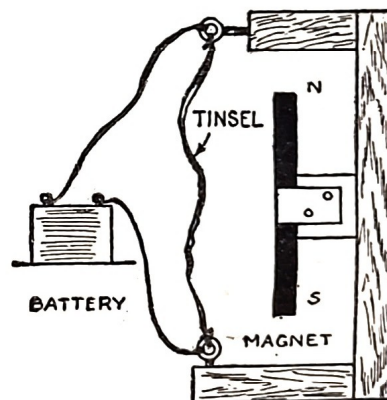
Hammer Kink



For driving nails in out of the way places, drill a hole in the hammer as shown above. The nail is held in position by a bit of beeswax. It can then be driven into the wood without the usual bruising of the fingers. When the nail is started, the hammer can readily be removed from it.

—Florence E. Moore.

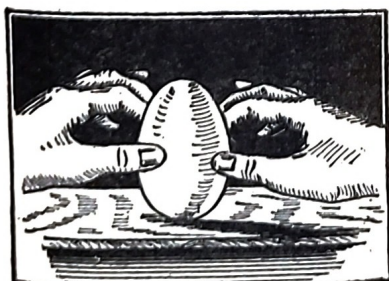
Magnetic Snake



A piece of tinsel suspended as shown above will perform violent contortions when current is passed through it. Also try reversing the current.

—S. Leonard Bastin.

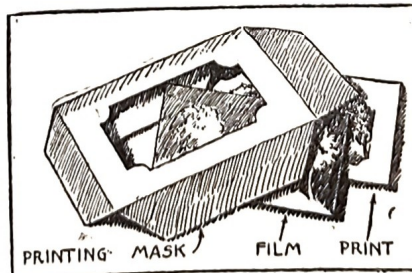
Egg Trick



Hold an egg as shown above for a moment or two. The yolk will settle and with a little manipulation the egg will balance perfectly.

—C. L. Walter.

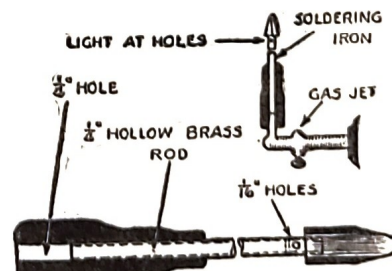
Printing Mask



A satisfactory printing mask may be made from an envelope as shown above, cutting the face of the envelope to the desired shape.

—A. P. D'Ambra.

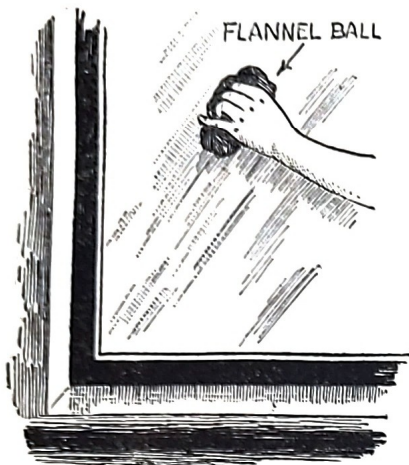
Soldering Iron



A soldering iron made as shown above can be quickly and easily heated over a gas jet. The flame ascends through the brass rod.

—George A. Coates.

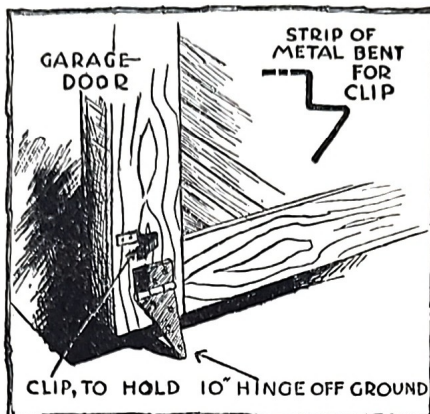
Preventing Steaming



Roll a narrow strip of flannel into a ball, drop a few drops of glycerine thereon and apply to a glass surface. Spread the glycerine over the surface smoothly. This will prevent the steaming of windows or eye glasses in winter and also makes a good application to prevent water from collecting on the automobile windshield.

—C. A. Oldroyd.

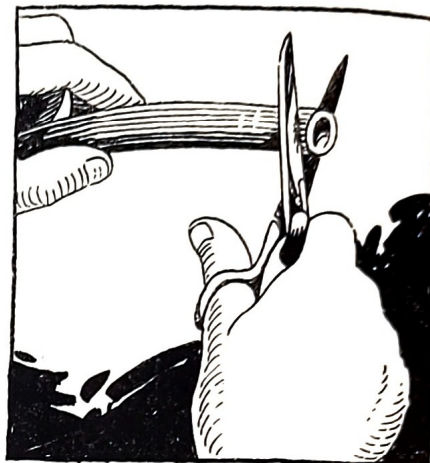
Door Catch



A 10-inch hinge screwed to the lower part of a garage door makes an excellent catch for holding that door open. The point of the hinge digs into the ground. It is of course placed on the inside surface of the door. A clip holds the hinge off the ground when not in use.

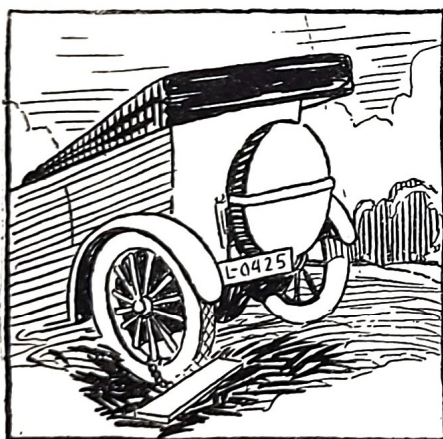
—Robert J. Williams.

Rubber Washers

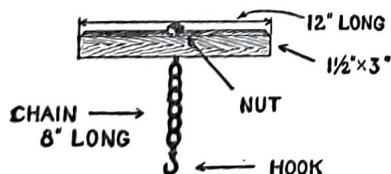


Small rubber washers for various purposes can be obtained by cutting pieces off the end of a rubber hose of the correct diameter. The process is illustrated above. These washers have various uses in the experimenter's laboratory and often are hard to obtain in the correct length and diameter. By this method the length can be any desired.

Auto Aid



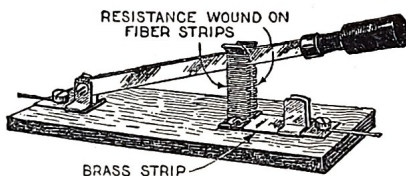
The device illustrated below is shown in use above. The hook engages with a spoke in the wheel and by putting the automobile gear in reverse and engaging the clutch slowly, a car can be pulled out of a bad mud hole.



The details of this "mud hook" are shown directly above. Any block of wood may be used. A chain and hook are attached as shown. It is wise precaution to carry a device of this nature in the car at all times as one never knows when it may come in handy.

—George E. Griffin.

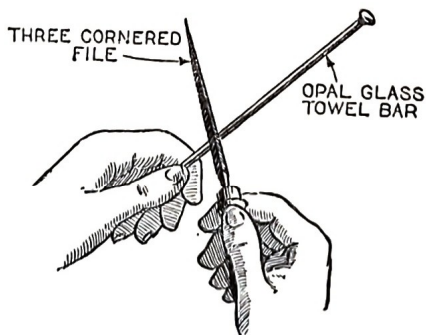
Starting Switch



A starting switch for small motors may be easily made by winding a few feet of resistance wire on two fibre strips as shown. The lower ends of the windings are connected to the brass strip. As the switch is slowly closed, resistance is gradually cut out of the circuit until finally the blade touches the jaw and the motor attains full speed.

—Thomas McCartie.

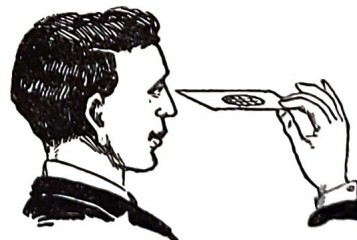
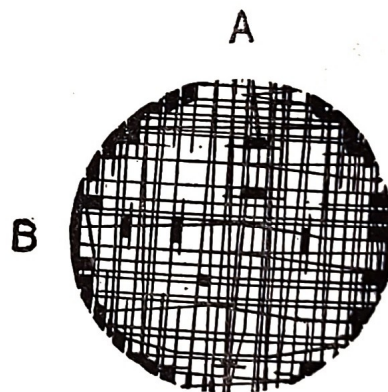
Stirring Rods



Stirring rods for photographic purposes may be made by cutting a glass towel bar in half. This may be quickly and easily accomplished by scratching the glass with a three-cornered file and then breaking at that point. Smooth the ends off with a file or emery paper.

—L. M. Holden.

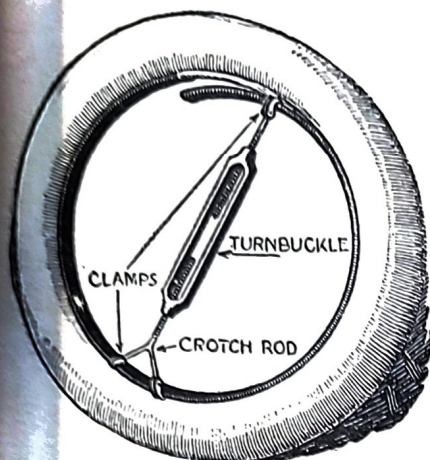
Advertising Device



The above illustration shows a method of advertising. The lines on the circular figure are unintelligible when viewed in the ordinary manner, but if held in an edgewise position as shown, words become visible. By turning the top 90 degrees to the left, another phrase can be seen. By exercising a little ingenuity in the combination of words and phrases, other designs may be made.

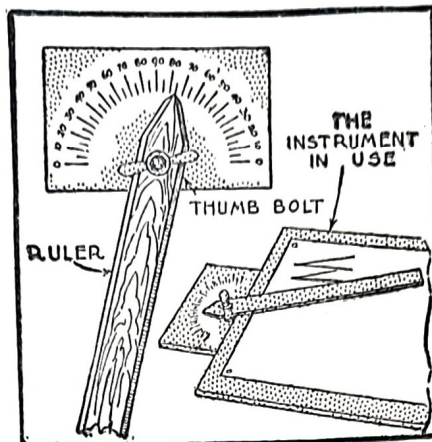
—J. E. Peterson.

Rim Tool



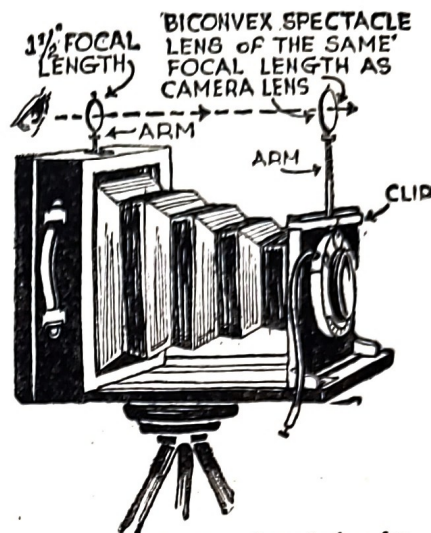
By using a turn buckle and crotch rod with a total over-all length of about 31 inches, the home mechanic can make a very effective tire tool. It is used as shown. —Vernon Goetz.

For Draftsmen



With protractor angles painted on a block of wood as shown, and a ruler attached to the block with a wing nut, any given angle may be drawn at once. —Evermont Fisel.

Camera Focus



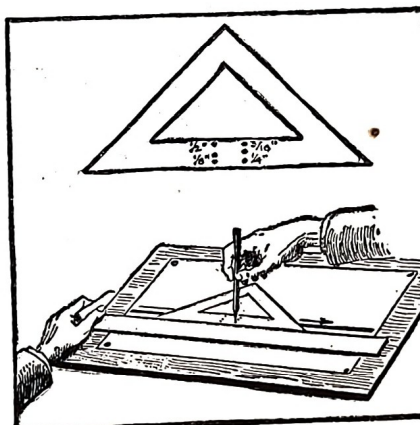
An automatic focussing device for cameras can easily be constructed with a bi-convex spectacle lens with the same focal length as the camera lens, and a second lens of about $1\frac{1}{2}$ inch focus. —C. A. Oldroyd.

Timer



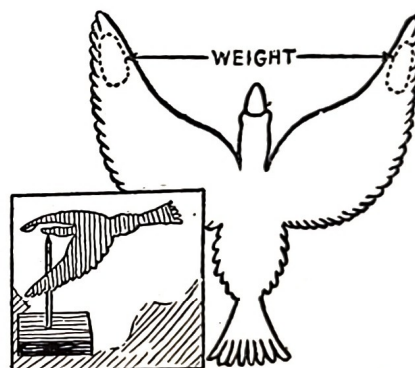
For photographers and others who deal much with timing devices, the above kink will help. An arrow cut from black paper is pasted on to the back of the clock crystal. If a certain period of time is wished, the arrow is simply pushed ahead a certain number of minutes automatically keeping track of the time. —C. A. Oldroyd.

Lettering



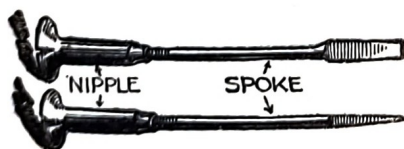
Holes drilled in the bottom of a triangle automatically designate the lining distance, doing away with the necessity for measuring it each time. —Geo. R. Robinson.

Perching Hawk



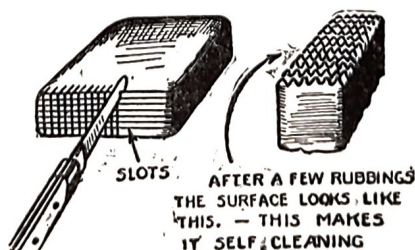
If a bird is cut from stiff paper on the outline shown above, about ten inches from wing to wing, and the wings are weighted with lead, the birds will perch as shown. —A. P. D'Ambra.

Screw Driver



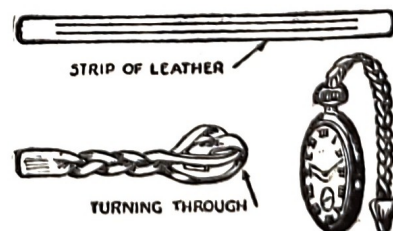
A handy screw driver for radio and small motor work can very easily be made from a bicycle spoke and nipple. As in the above photograph a spoke is cut off about three inches below the nipple and sharpened with a file. The spoke is screwed in as far as possible. —A. P. Peck.

Eraser



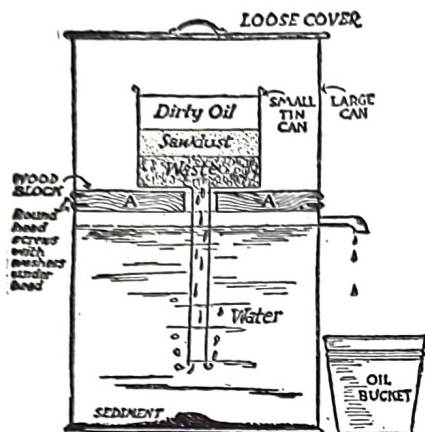
Indentations in the edge of an artist's eraser greatly facilitate its work. —Marcel Papin.

Watch Chain



A handy watch chain is made by braiding a piece of leather cut as shown above. —John F. Shelby.

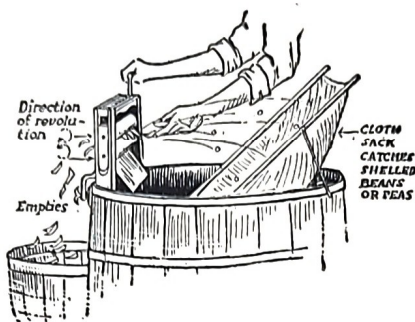
Oil Filter



The oil filter illustrated above will bring in many times its value to its owner. Across the center of a 10-gallon can place a wooden shelf to hold the center can, which has a tube attached to its bottom. This can is filled with the filtering substances, sawdust and waste. The oil seeps through, bubbling up through the water.

—J. E. Noble.

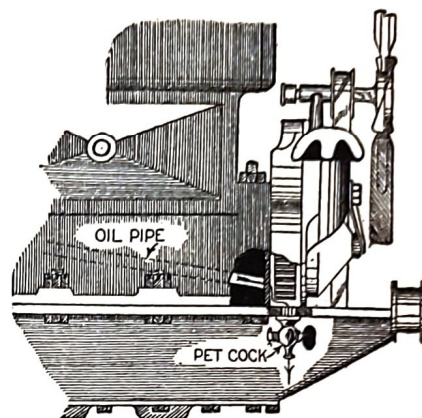
Bean Sheller



The old family wash wringer is here given a new use. When beans, peas, etc., are being preserved and consequently shelled in large quantities, the above kink will obviously be found very useful. The pods are fed into the wringer as shown. The squeezing force of the rollers force the beans to shoot back against the cloth catcher and carry the pods through into the waste basket on the other side of the wringer.

—N. W. Hopkins.

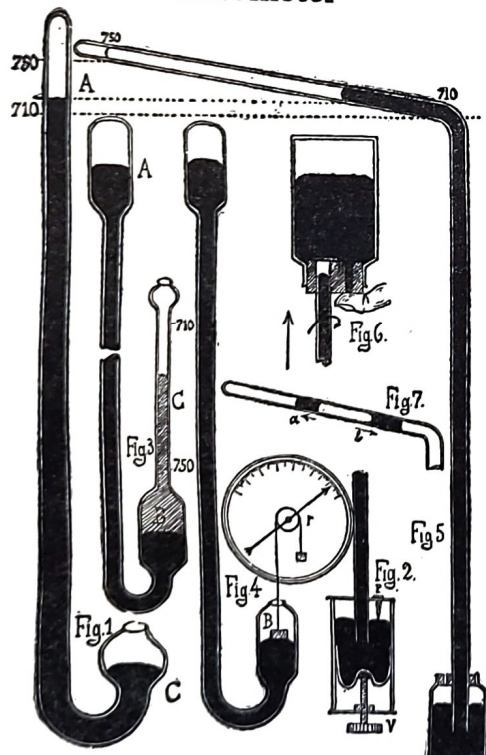
Oil Tests



If a small pet cock is installed directly under the large timing gear on a Ford motor an excellent indicator is had as to whether the oil in the motor is circulating properly or not. The pet cock is installed by drilling a small hole in the case just under the timing gear and tapping it to take the cocks shank.

—Harold Jackson.

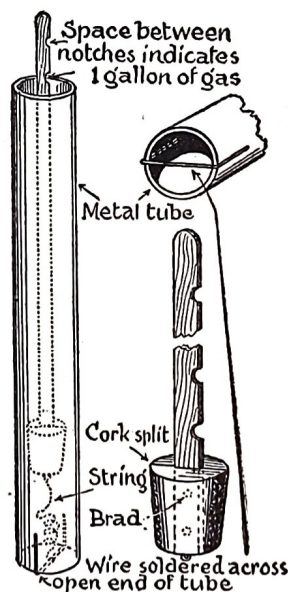
Barometer



1. The barometer. 2. Pontin's B. Mercury in a chamois bag adjusted by the screw. 3. Huyghens' B. colored liquid gives the reading at C. 4. Hooke's B. the dial and index magnify the reading. 5. The mercury in the inclined tube magnifies the reading greatly. 6. Filling No. 5 the cistern is seen inverted over the lower end of the tube. 7. a Convex meniscus—B. is rising; b Concave or flattened meniscus—it is falling.

—P. Medinger, Luxembourg.

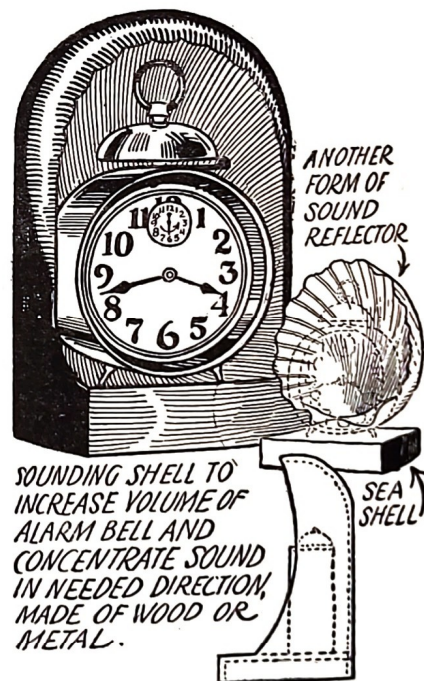
Gasoline Gage



For those cars not equipped with direct reading gas gages the above illustration shows a method which will be found exceptionally useful. A tube slightly longer than the depth of the tank has at one end a piece of heavy wire across it. A cork of slightly less diameter than the tube is fitted with the stick as shown. The stick is notched at points indicating full gallons; both stick and cork are shellacked. A screw eye fits in bottom of cork from which a string runs to the wire across the bottom of the tube. To measure the gasoline simply insert the gauge in the tank and count (feel) the notches above the top of the tube.

—L. B. Robbins.

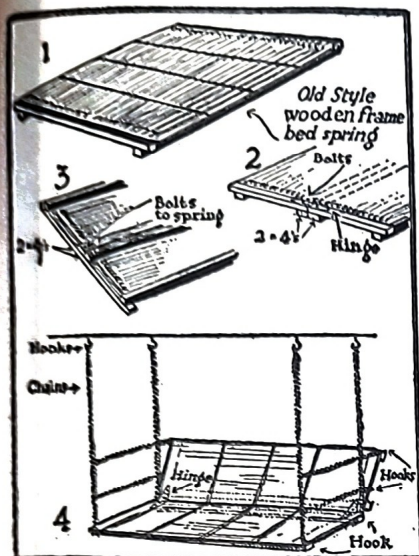
Improved Alarm



The above illustration graphically shows a method of concentrating the energy from the alarm clock bell by constructing the resonator-like housing similar to the one shown in the above illustration. The sound from the alarm bell is thus thrown out in one direction so that the greatest volume is obtained where it is needed. This resonator can be constructed of wood, metal or shell. It directs the sound from the alarm in much the same manner as the bell directs the sound of a trumpet or cornet.

—Thomas H. Duffy.

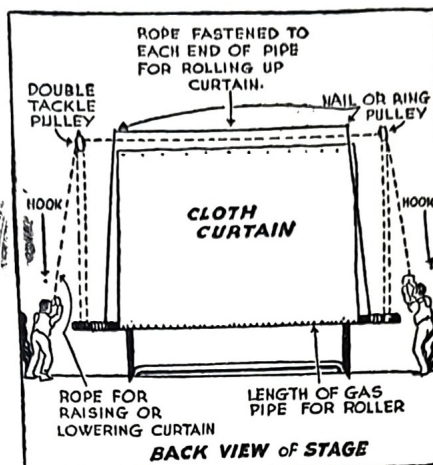
Porch Swing



Old style wooden frame bed springs lend themselves admirably to the making of a porch swing by the use of two 2x4's, two hinges, and some chain. The ingenious home mechanic will find it easy to build a sturdy porch swing like this from pipe and fittings.

—Mrs. H. D. Jepson.

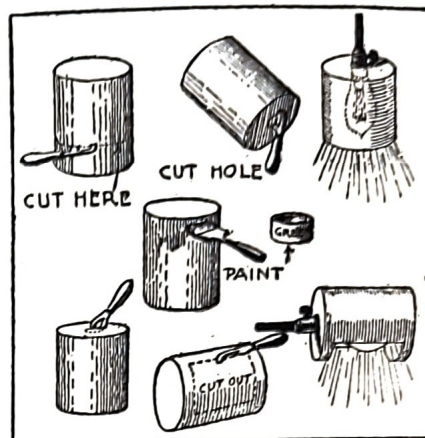
Drop Curtain



Secure a piece of gas pipe four feet longer than the proscenium opening, two double tackle pulleys, a few nails and a cloth curtain. One of the ropes passes upward to the double tackle pulley, then loops around the pipe and goes back to the same pulley. From this point it crosses to the other side, where the rope circuit is duplicated. A second rope secured above the proscenium, passes downward on either side and is fixed to the pipe.

—Miss Fern Smith.

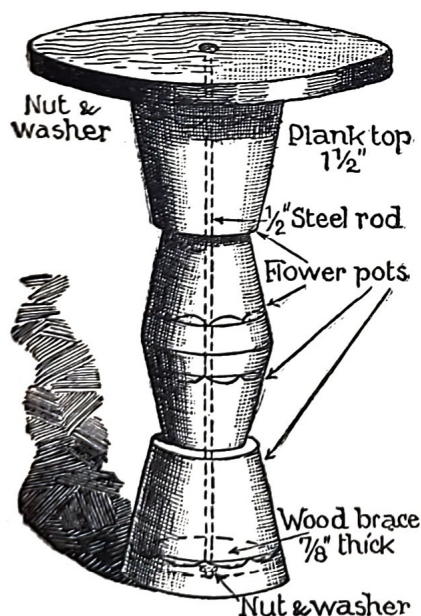
Lamp Shades



Shades for electric lights may easily be made with the aid of a can opener and a little paint. Two styles of such shades are shown in the illustration above. For making the first style, remove the bottom of a large tin can. An opening is then made in the top to fit the socket and the whole is painted a desirable color. The inside could be painted white, or may be left in its polished metallic state. A second form of shade for goose neck lamps is also shown.

—E. Joy Betterley.

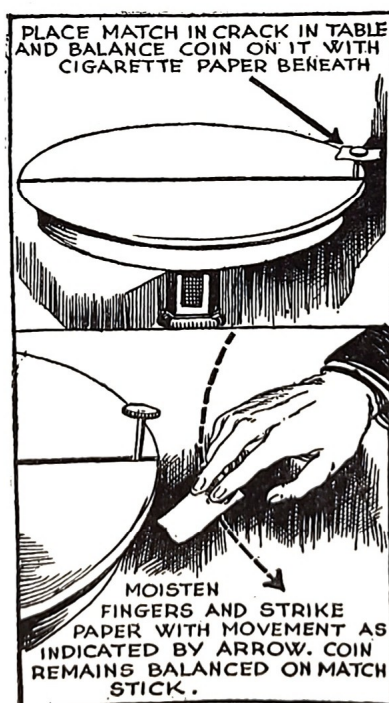
Flower Stand



The sketch above shows how to make a novel lawn or porch stand with a few flower pots, a length of 1/2-inch steel rod threaded on each end, and two bits of wood. The top of 1 1/2-inch wood is circular. It has a hole in the center through which the steel rod passes. Another circular disk is placed into the bottom flower pot where it acts as a brace for the steel rod. The whole makes a very artistic flower stand.

—W. J. Markowski.

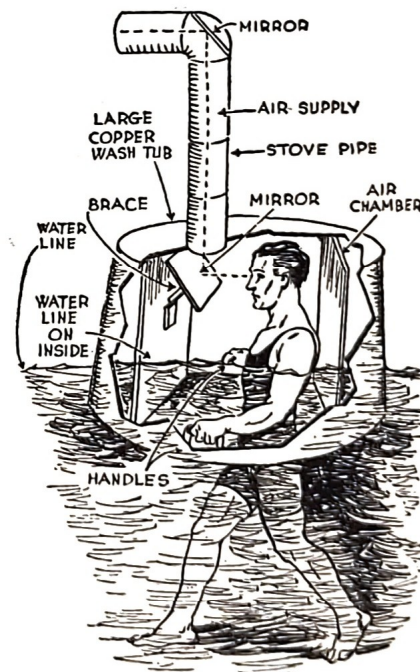
Parlor Trick



It is comparatively easy to balance a coin on the end of a match if the principle shown above is followed. The stunt is quite mystifying.

—Sam Colson, Reporter No. 3888.

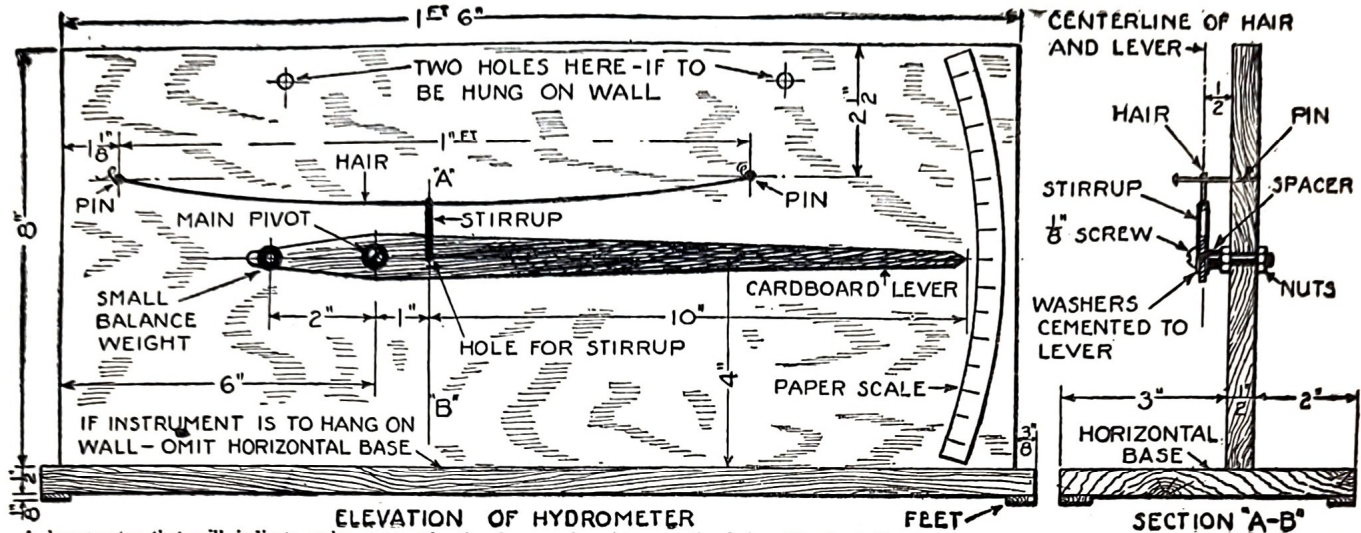
Submarine



Lots of fun will be added to the summer's sports if a submarine as illustrated herewith is made. Mother's washtub, some stove pipe for which there is no use in the summer time and a couple of mirrors make an inverted floating tub with its periscope which can be maneuvered by the swimmer as a submarine, resulting in much amusement.

—Lester O. Eten.

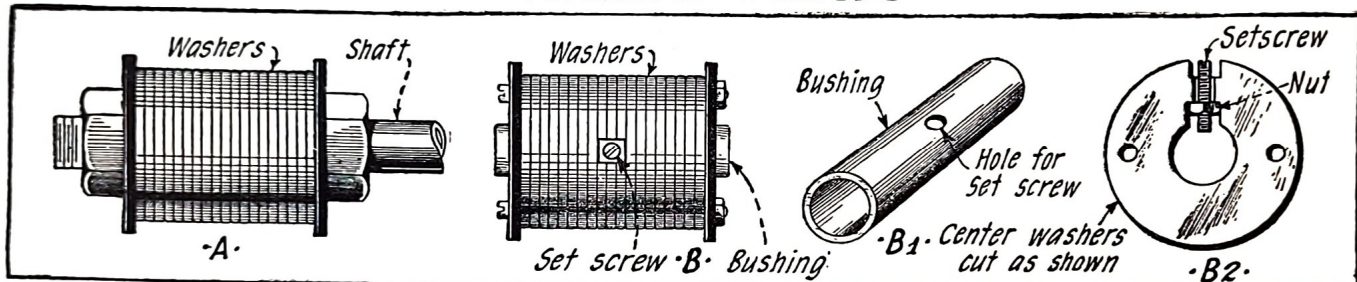
A Sensitive Hygrometer



ELEVATION OF HYDROMETER
A hygrometer that will indicate quite accurately the degree of moisture contained in the air may be constructed as shown above. A human hair constitutes the expanding element, but it must first be boiled in water for ten minutes to increase its sensitiveness to moisture. A stirrup connects

the hair with the indicating lever. A paper scale completes the device. The fact that the hair is essentially horizontal gives the apparatus extreme delicacy as a minute change of length in the hair is greatly enlarged in effect.
—C. A. Oldroyd.

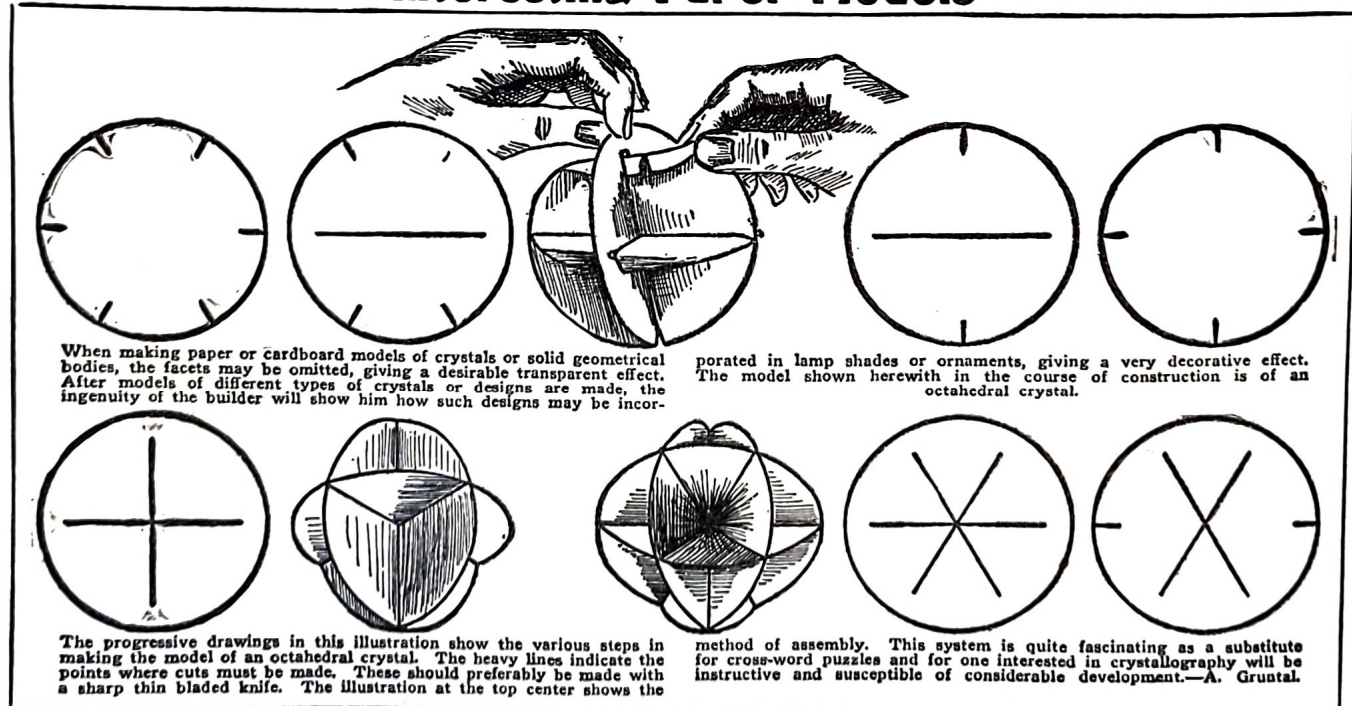
Emergency Pulleys



When a pulley is needed in a hurry and one of the required size is not at hand, washers may be used to build up an emergency makeshift which will give good results. Where a shaft is threaded at the end, the type illustrated at A may be used. Where the pulley has to be slipped over a shaft, the type illustrated at B must be employed. A bushing is necessary as in

B1 and the center washers are cut as in B2, allowing the use of a set screw. By using fibre washers, which are procurable everywhere, a most substantial pulley of any desired width may be readily built up for belts of any kind.
—Alvin Hedvall.

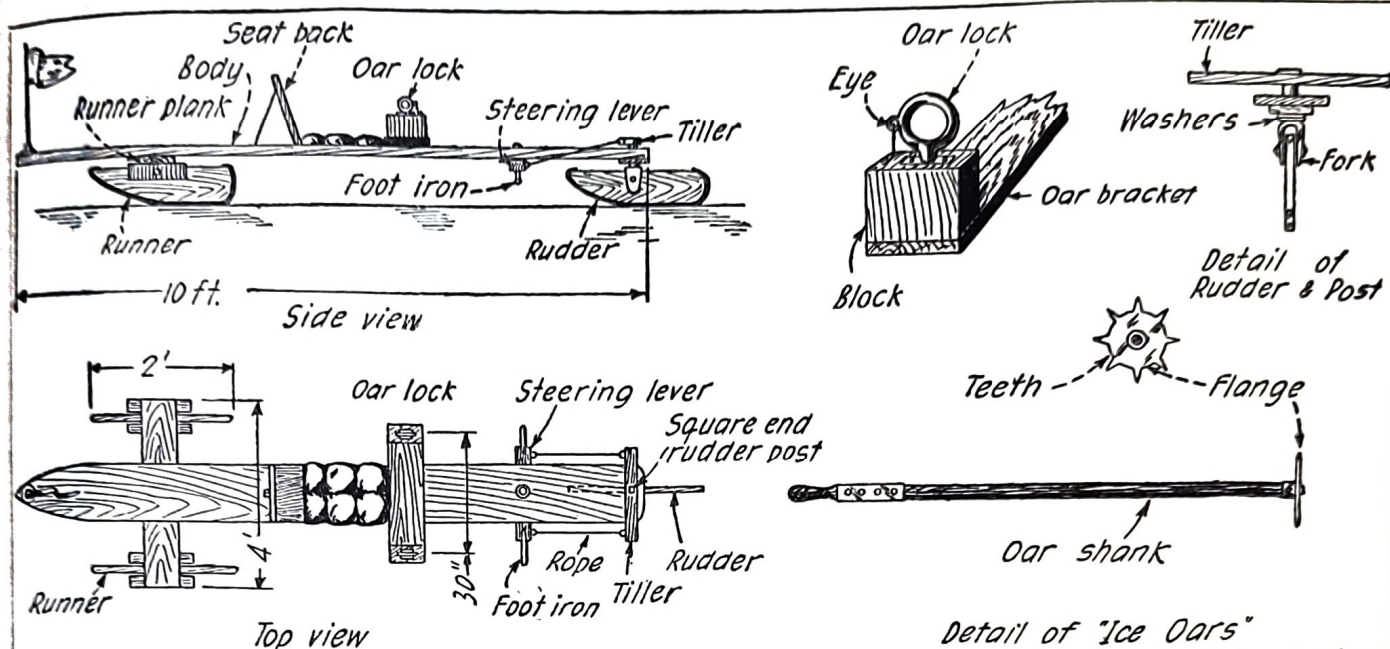
Interesting Paper Models



The progressive drawings in this illustration show the various steps in making the model of an octahedral crystal. The heavy lines indicate the points where cuts must be made. These should preferably be made with a sharp thin bladed knife. The illustration at the top center shows the

method of assembly. This system is quite fascinating as a substitute for cross-word puzzles and for one interested in crystallography will be instructive and susceptible of considerable development.—A. Gruntal.

Hand-Propelled Ice Skiff

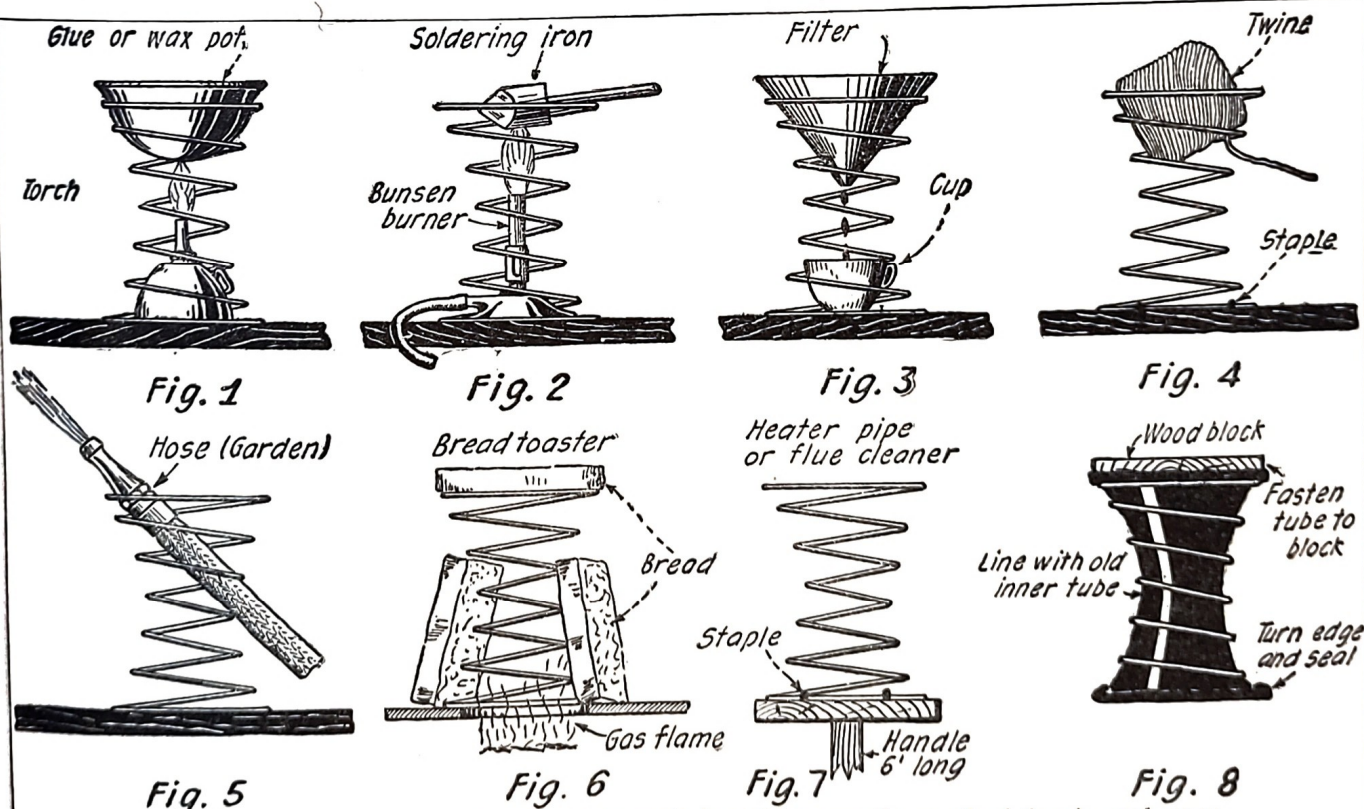


The above shown skiff is very similar in design to the regular ice boats. The principal difference is that it is hand rowed. The "oars" are of wood with a spiked wheel at the end that

grips the ice. All wood construction should be of oak or hickory.

—L. B. Robbins.

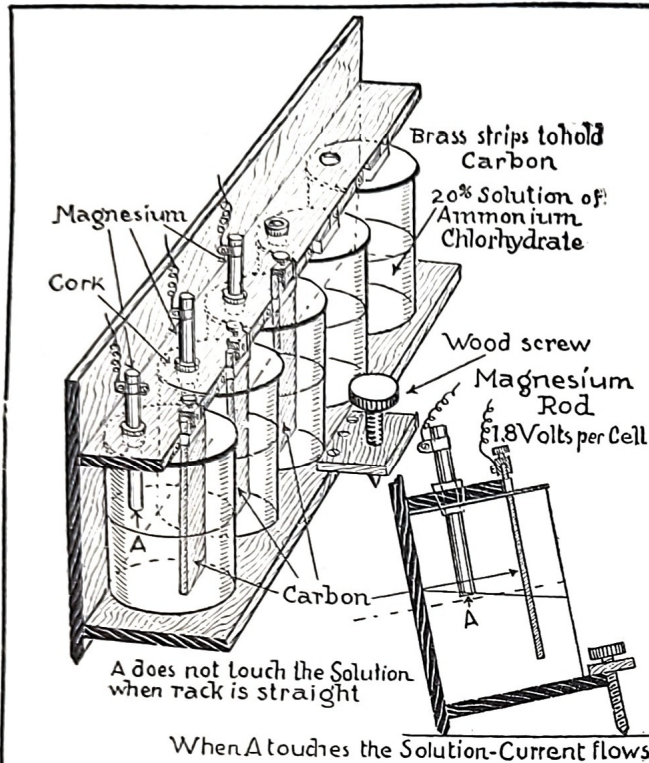
Coil Bed Spring as General Handy-Man



Nothing is quite so handy as a coil bed spring. One of its most valuable uses is as a force pump for cleaning drains. (Lower right corner). Place the bottom of the spring, lined with an inner tube, over the mouth of the pipe and pump.

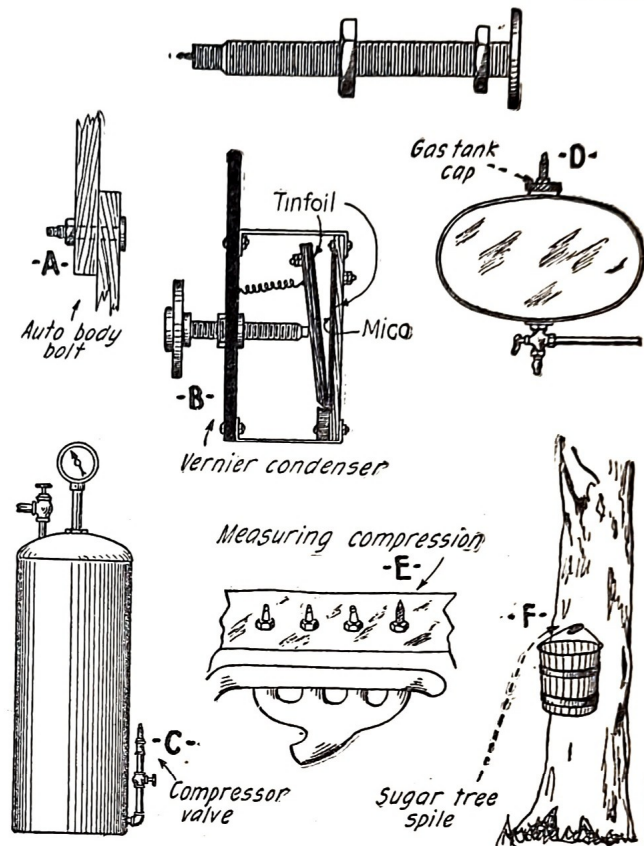
—W. T. Markowski.

Novel Wet Cell

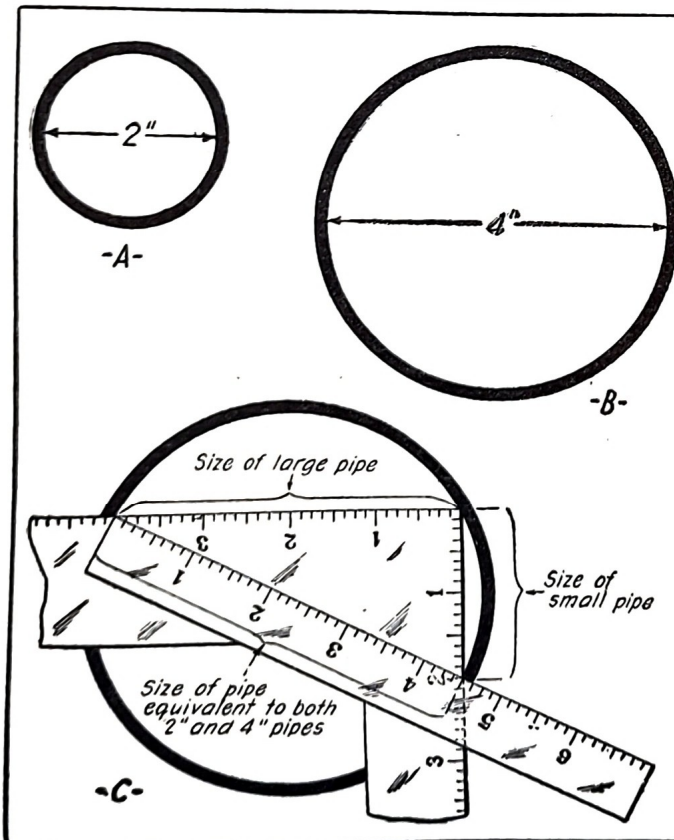


A simply constructed battery that will deliver 1.8 volts per cell. It is constructed of carbon and magnesium rods in Ammonium Chloride. The thumb-screw takes the magnesium out of the solution when the cell is not in use.—Chas. Mohr. At the right are shown several uses for discarded valve stems. A—As a bolt. B—As an adjustment screw for book-type variable condenser. C—As an intake valve for a compressed air tank. D—As an air valve in the top of the fuel tank. A few strokes of the pump helps the car over the hill. E—Compression tester. F—Sugar tree spile.—J. T. Garver.

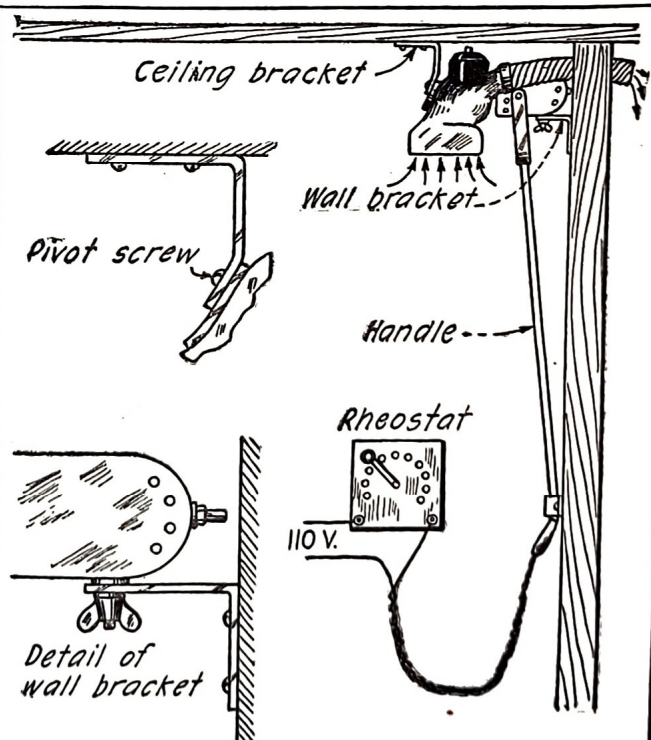
Uses for Valve Cores



Pipe Size Changes



Vacuum Cleaner Use

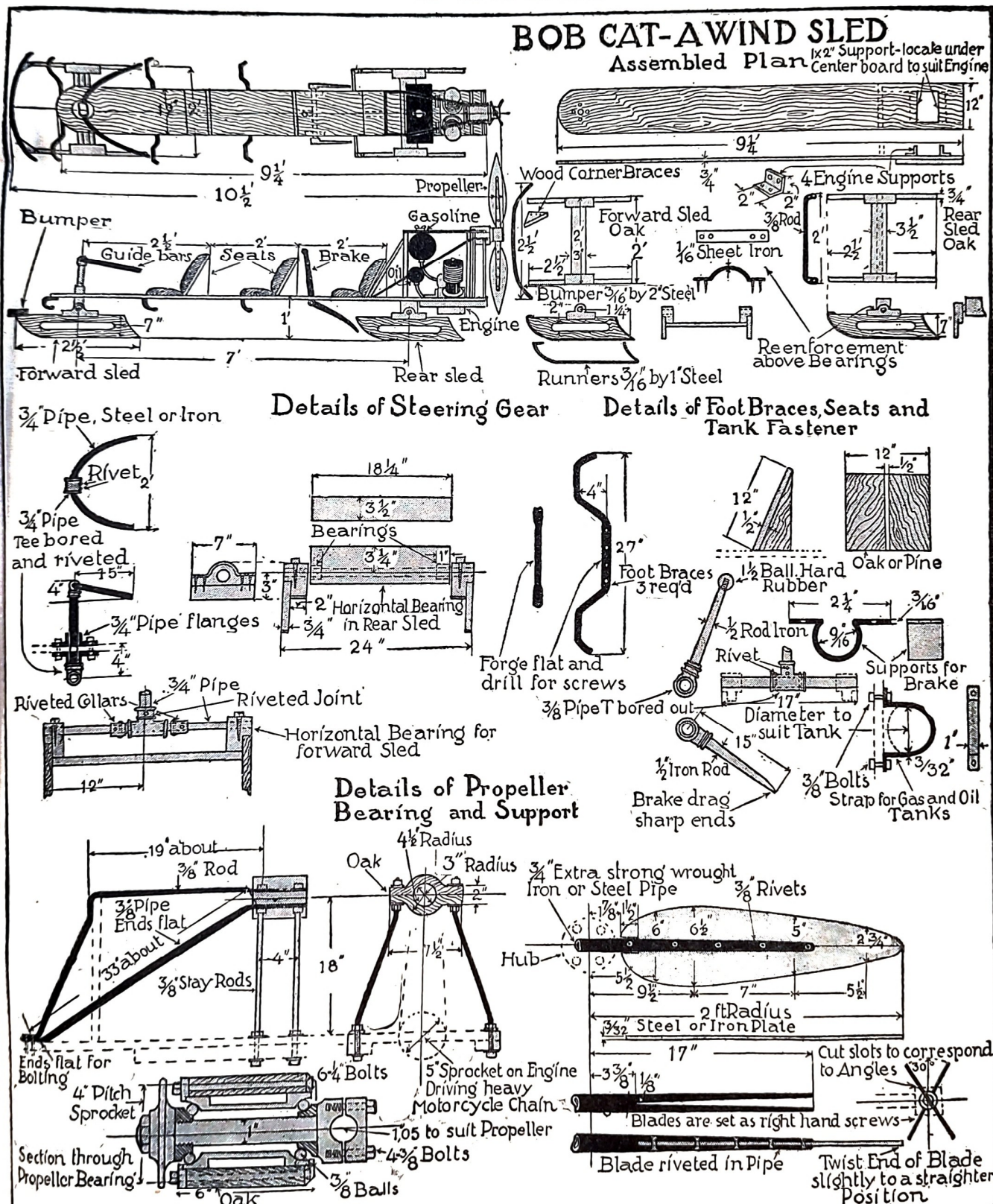


At the left is shown a simple method of finding a large pipe that will carry the same amount as two smaller pipes and vice versa.—Geo. G. McVicker. Above is shown a method of using the vacuum cleaner to force fresh air into rooms where ventilation is impracticable by ordinary methods, such as dark rooms.—L. B. Robbins.

"Bobcat"--An Air-Propeller Sled

Capable of Fifty Miles Per Hour On Ice

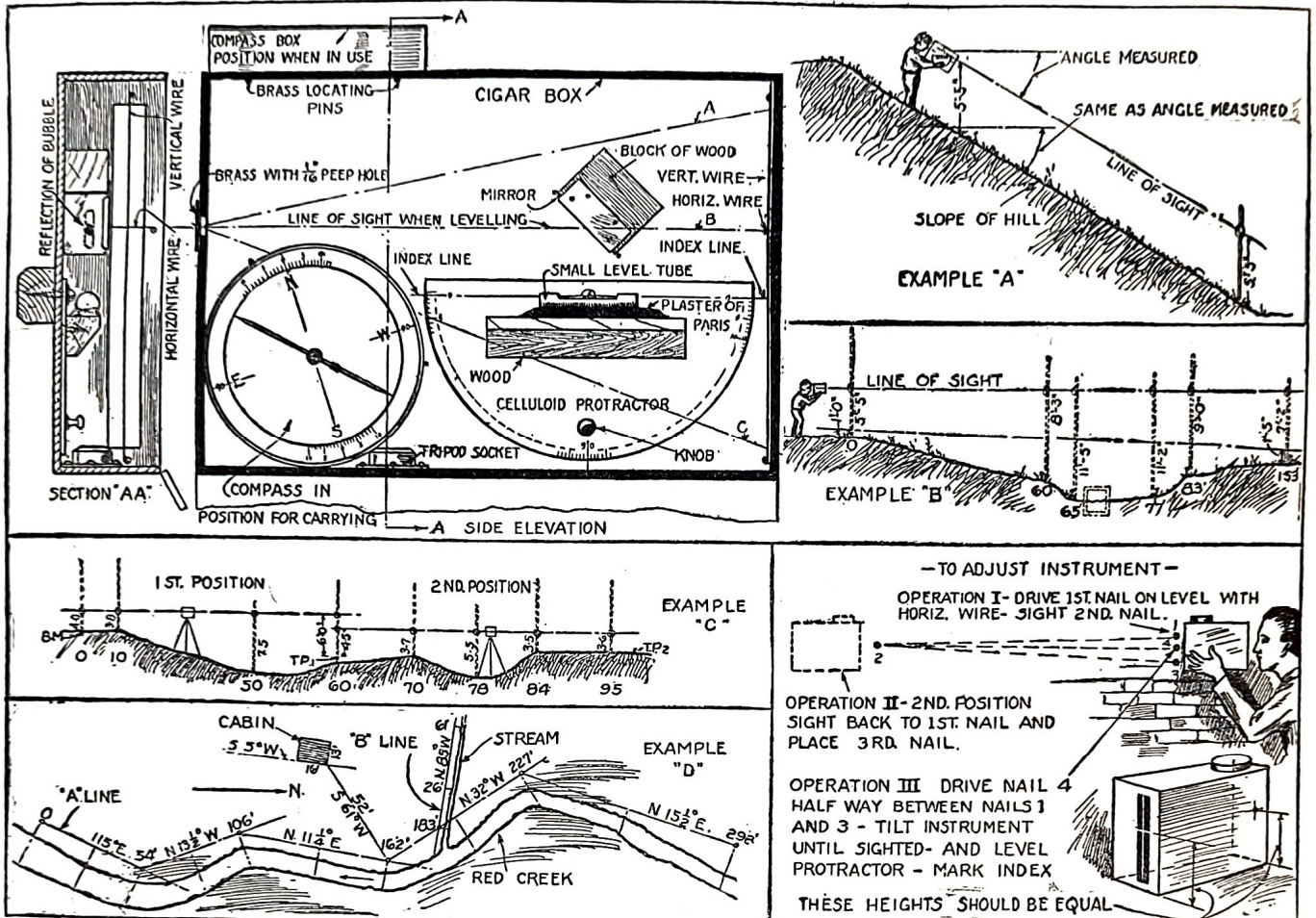
By G. A. LUERS



Equipped with a twin cylinder engine of the motorcycle type developing between seven and ten horsepower, the wind sled whose structural details are shown above, will work over back snow and moderate hills, fully loaded. On ice it will develop upwards of fifty miles per hour. The method of constructing the body is shown in the plans. The cost is very

moderate since the engine can be procured at from ten to thirty dollars. It need not be in the best of condition. A motorcycle sprocket shaft and bearings supply the propeller journals. The propeller is made of sheet steel and is firmly riveted into the steel tubing which carries it. The weight of the completed sled is just slightly over 200 pounds if the details given above are followed.

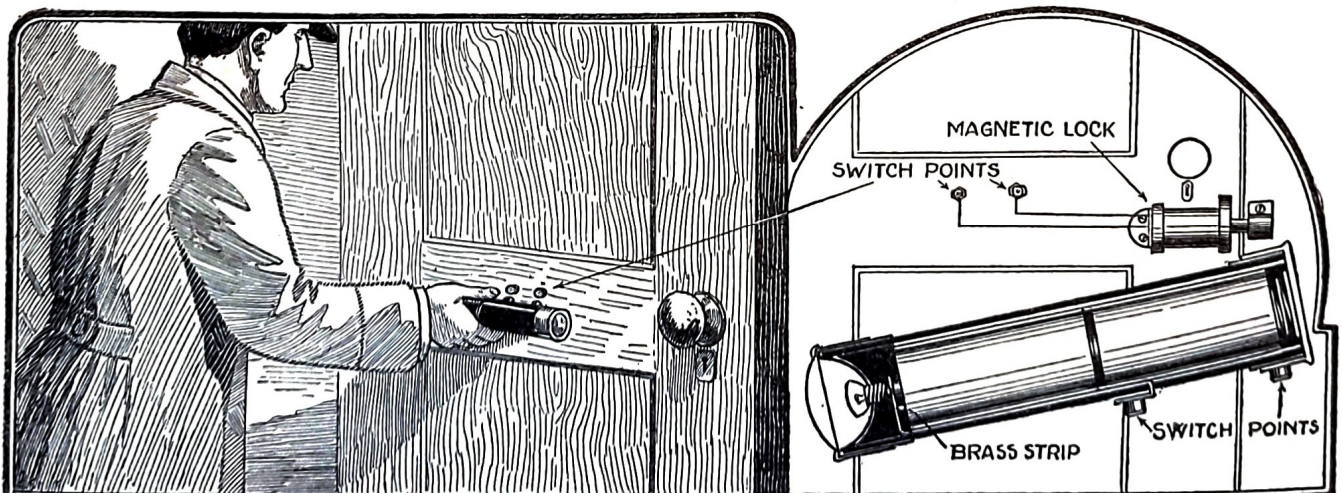
Amateur Surveyor's Transit



For making the above combined transit and level, procure a perfect cigar box, cut the vertical slot in one end as shown. Then drill a $\frac{3}{16}$ " hole through the opposite end, and cover it with a piece of brass containing a $\frac{1}{16}$ " deep hole. Measure the height carefully of this hole above the box bottom. At exactly the same height, pass the horizontal cross-hair which can be made of a fine wire well across the slot. Place the vertical wire in the center and exactly parallel to the side of the box. The vertical wire is placed exactly the same distance from the side of the box as the center of the brass peep hole. The compass is placed on the top of the box with the north and south line of its dial passing directly through a line drawn through the

vertical cross-hair and the center of the peep hole. Two pins in the compass bottom fitting in holes in the top of the box serve to keep it in place. To the inside of the box a piece of good white drawing paper is glued. A protractor is pinned to a small strip of hardwood, and the level is held to the protractor with plaster of Paris. This level must be exactly parallel to the flat side of the protractor. A screw is run through the exact center of the protractor and fastened to the back of the box. The mirror on the block of wood is placed as shown. The method of using the transit for measuring angles, leveling, and running straight lines is explained in the sketches. Adjustment is also explained. —H. E. Balfour.

Magnetic Door Locks

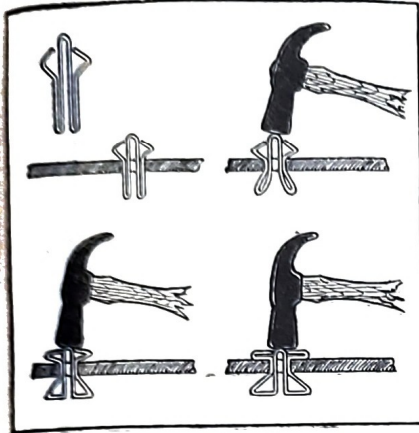


By fitting a flashlight with two switch points, as illustrated at the right, and constructing a magnetically operated lock, the experimenter will have produced something rather unique; the door cannot possibly be opened by anyone unacquainted with the secret.

Pressing the switch points upon two others mounted on the door, operates the solenoid and causes the bolt to be drawn into it, thus opening the door.

—Philippe A. Judd, Reporter No. 7297.

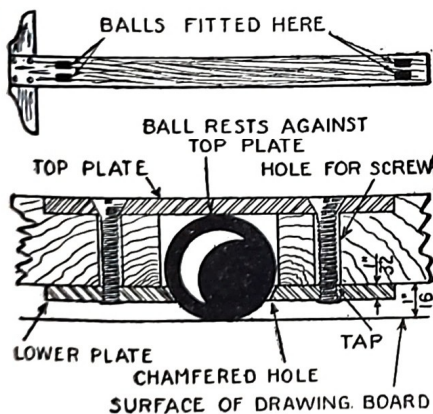
New Rivet



A rivet that is self-clinching and does not require the use of a metal backing of any kind is shown in use above. The illustration in the upper left-hand corner shows the rivet ready for use. It may be used for holding sheets of metal together and also may be employed in place of toggle screws. For fastening together the corners of steel stock bins, this rivet is most available. Only a hammer is needed to apply it. The various steps are shown clearly above. The rivet is placed in the hole, and is then hit with a hammer. For simplicity, our drawings show only one sheet of metal, but the rivet is to be used for fastening together two or more sheets. With one blow of the hammer, the rivet is changed from the shape shown in the first of the progressive diagrams to that shown in the last of them.

—Walter T. Markowski, Rep. No. 192.

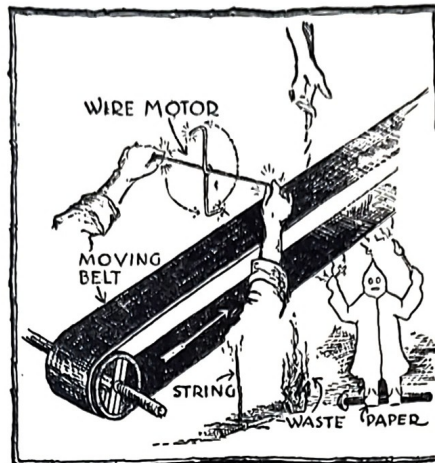
Tee Square



Fitted with the ball bearings shown above, a tee square will travel over the whole of the drawing board with the greatest of ease, no matter how long or heavy the tee square may be. For large tee squares, four ball bearings should be used and are placed as shown. Two metal plates are used at each bearing and in one of them a hole is drilled and chamfered. The other plate is set flush with the top of the square and the two are held together by machine screws. This device has another advantage in that it keeps the tee square slightly above the paper and prevents the dirt marks that are often caused by the arm of the square.

—C. A. Oldroyd, Rep. No. 4433.

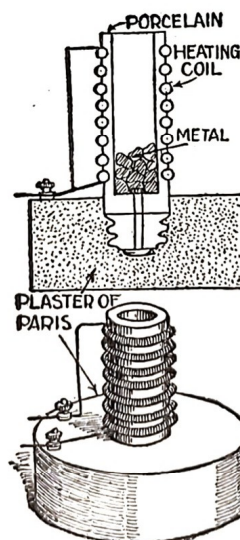
Static Generator



In shops or factories, where there are machines driven by leather belts, many interesting experiments in static electricity may be performed. A wire motor that will revolve briskly is made from two pieces of copper wire, one used as the shaft and the other, bent at the ends and center as shown, is used as the rotor. Bits of string or waste will stand perpendicular if held down with small weights. Grotesque paper figures will perform in the same manner. Bluish static discharges can be seen at the points indicated in the above drawing and are particularly spectacular in the dark. Sparks can often be drawn to the end of the finger, particularly on dry days.

—H. S. Fox, Rep. No. 5439.

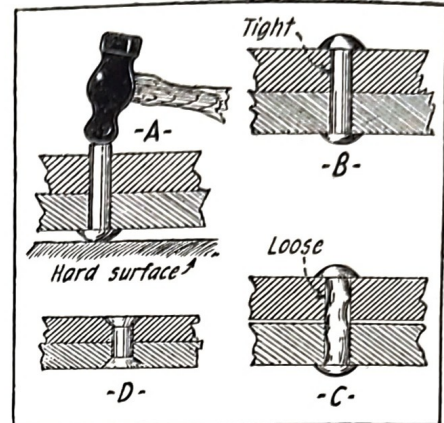
Furnace



A small electric furnace for use in the experimenter's laboratory for melting small quantities of metals may be made from a heating coil of the type used in standard electric reflecting heaters. The coil is mounted in a plaster of Paris base and leads are provided as shown. The metal to be melted is placed inside of the porcelain tube and the current turned on.

—E. C. Zimmerman.

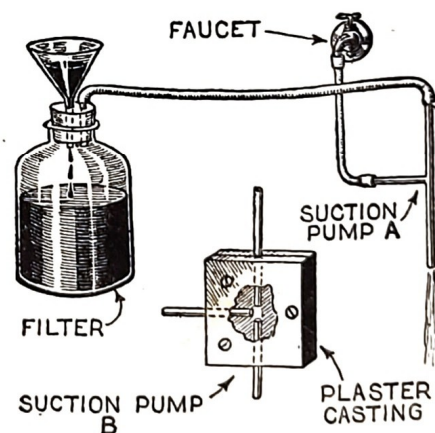
Riveting Hints



Even though rivets are most ordinary accessories in metal working, still it is surprising to note how often they are incorrectly applied. The holes that are drilled for rivets should always be just large enough for the rivet to slide through as at A and B. If the hole is too large as at C and the rivet is placed under any strain, it will soon bend out of shape and probably shear off. In any event, the joint will not be a tight one. When using rivets in wood, the drilled hole should be slightly smaller than the rivet whereupon the latter should be driven in. Of course, the correct hammer to use in riveting is the type shown at A. The end of the rivet should be smoothly turned over until it assumes the same appearance as the opposite end. Rivets set flush as at D should also be tight in the holes.

—Pan, Rep. No. 6535.

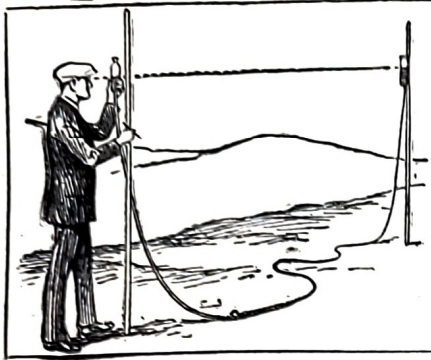
Air Pump



An air pump that is especially adapted to force filtering may be made by following the directions given above. Two different types are shown at A and B. The first is merely two glass tubes welded together in the form of a T. The water enters the short arm of the T and goes out through one of the long arms. As it does this, it carries bubbles of air from the other arm of the tee with it, creating a partial vacuum. A partial vacuum is therefore created in the receptacle of the filter and the filtering process may be carried to a completion very rapidly. The pump at B is made from three brass or glass tubes and two plaster casts bolted together as shown.

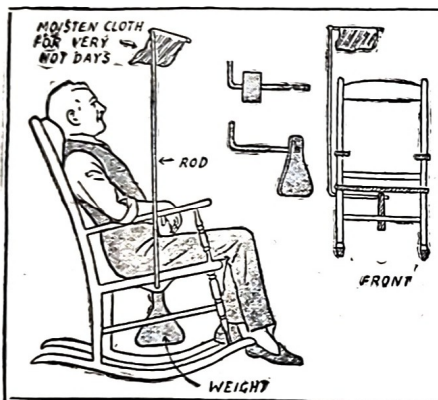
—C. A. Oldroyd, Rep. No. 4433.

Cheap Level



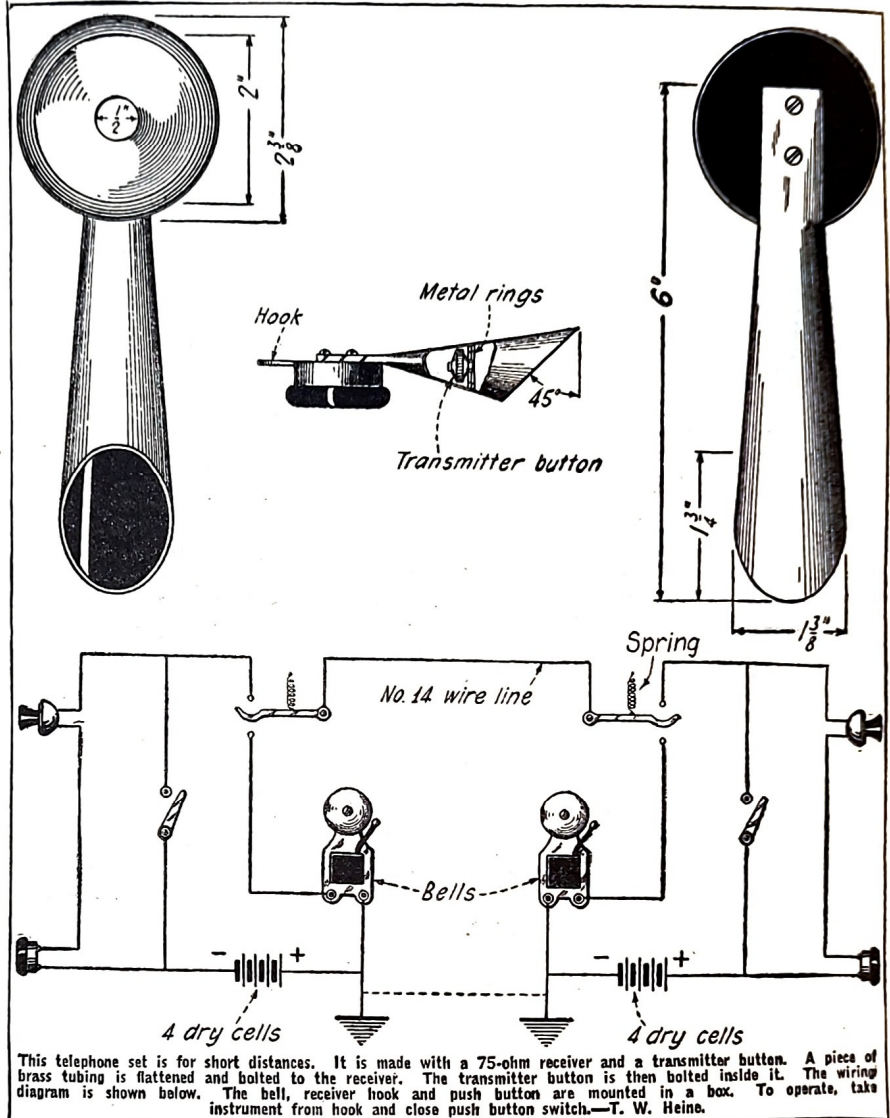
The leveling device shown in the sketch is one devised by Korean contractors. It is constructed of two glass tubes and a length of rubber hose. By mounting one of the tubes on a stick, as shown in the sketch, and raising the other until the water appears in the glass, then sighting over the surface of the water of the second at the column in the first tube a perfect level is produced.—C. A. Sauer.

For Hot Days

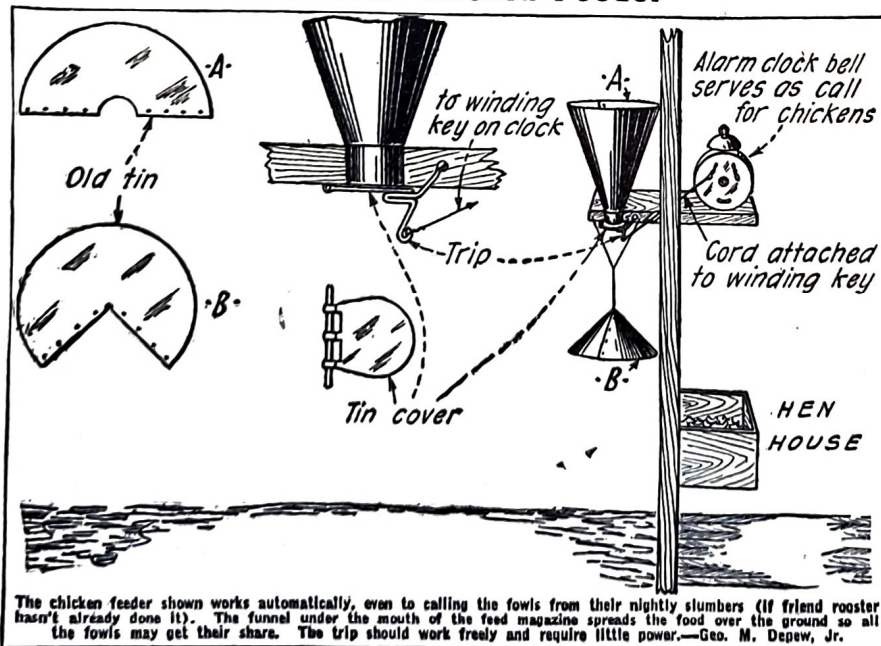


A fan that will operate with the motion of a rocking-chair is shown in the sketch above. Beneath the chair are placed two blocks, bored to be used as bearings for the rod that supports the counterweight. This weight can be of wood. The fan at the top is simply a large cloth slipped over the bent end of the rod.—John F. Pascik.

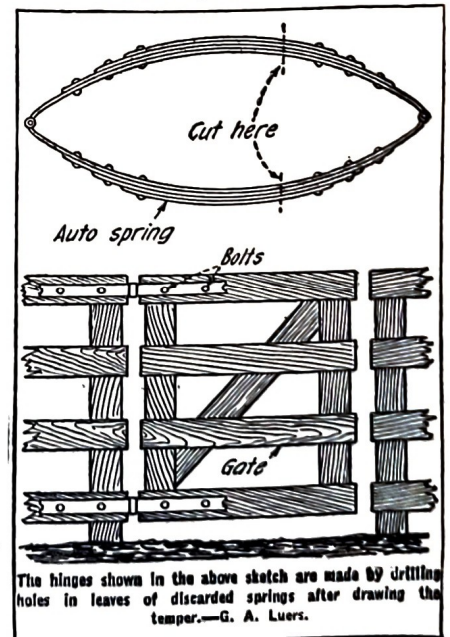
Short Line Telephone



Alarm Clock Chicken Feeder

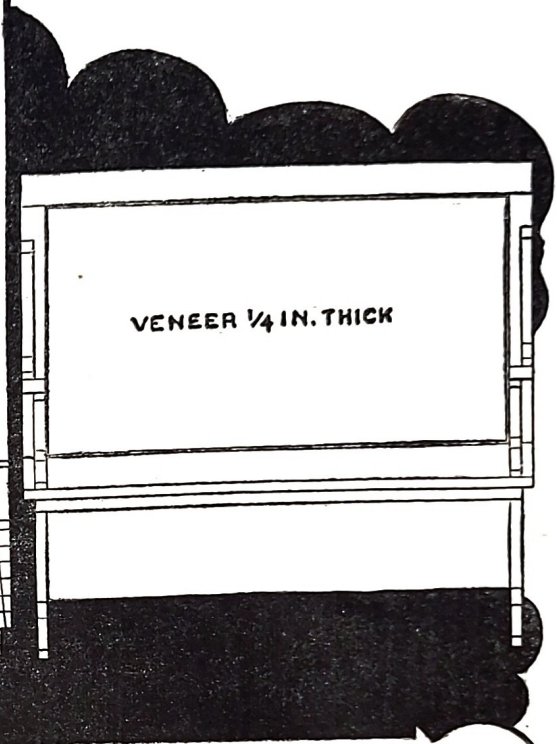
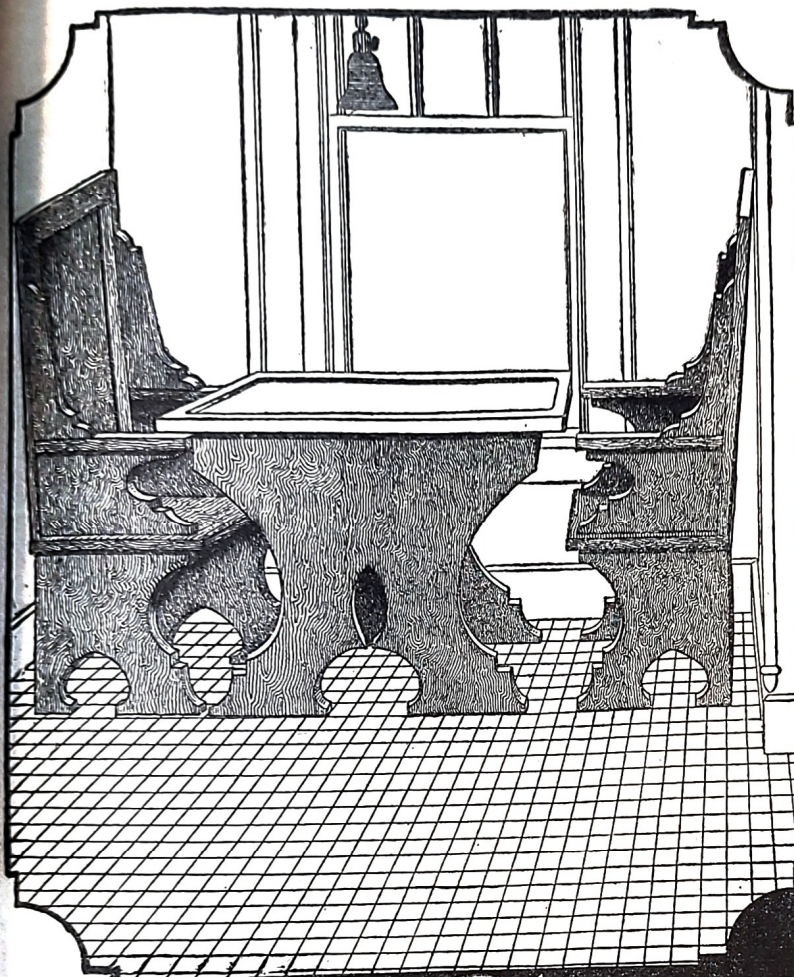


Spring Hinges



Breakfast Nook Furniture

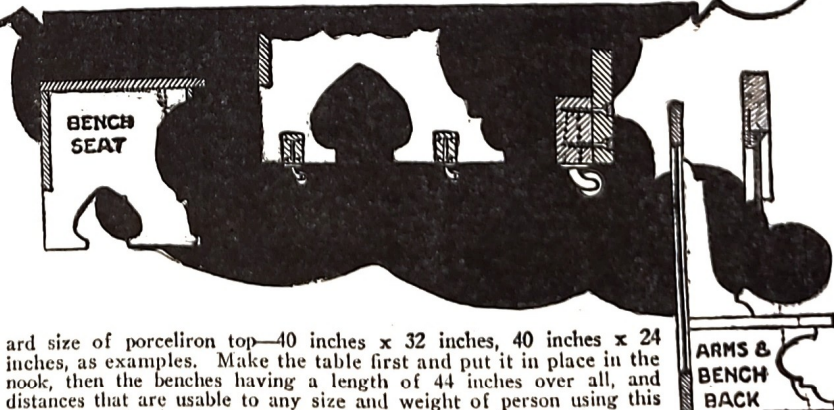
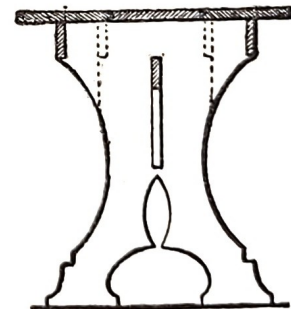
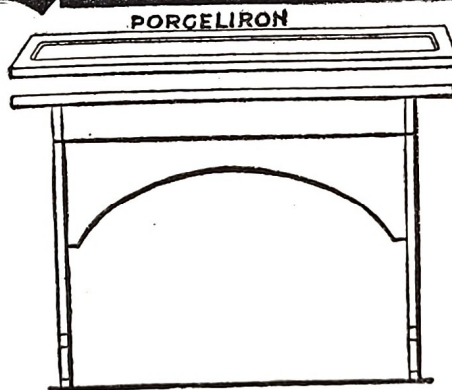
By W. M. BUTTERFIELD



THE usual method when the home builder makes a mistake in his breakfast nook is to shove the furniture in the nook where it stands wedged, all three pieces, closely together. The only way to occupy the benches when sitting at the table is to step over the first one; this is being done in many cases by home builders who willingly put up with this inconvenience for the sake of the nook.

The things that a home mechanic will be interested most in are the things that some builders have done to make misfit furniture practical and useful. One of the first things attempted it seems is to remove the front arm and its supports, thus having two one-arm benches. One can slide on this bench by partly bending the legs as in a sitting posture. But the bench does not look finished so some have taken away the remaining arms with the result that the benches have very unstable backs, and look like poorly designed garden benches. The like poorly designed garden benches. The arms and supports have usually been put back, first having the arms and supports shortened to make these parts of the benches usable. The seat and ends are cut away in the same manner (see dotted lines on detail drawings). In other cases the table has been the only point of attack (the cut away methods are also represented in dotted line on a table drawing).

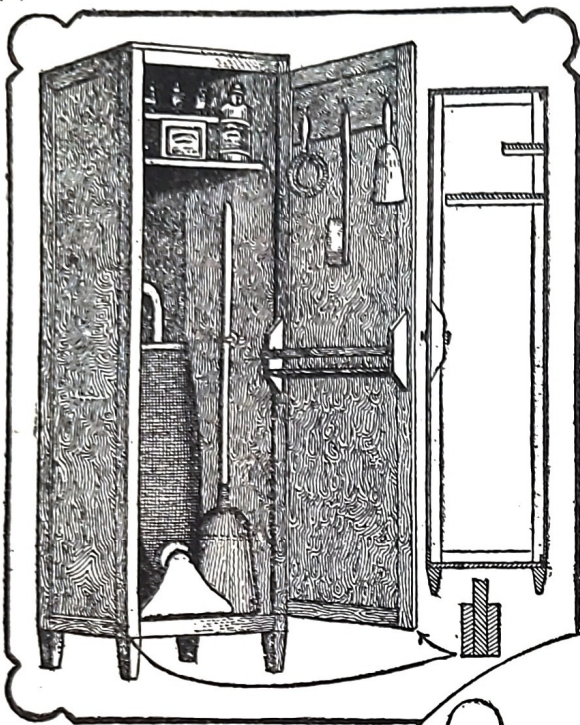
The result of all this wasted effort has shown builders that it does not pay, from a decorative sense anyhow, to alter the original lines of any piece of furniture. The drawings above show a mingling of the best styles of unmitigated nook furniture. The perspective view shows furniture wedged and having the proper distance between table and bench. We would suggest that the home mechanic construct his table to fit a stand-



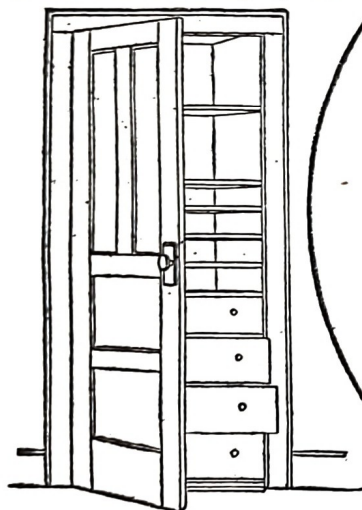
ard size of porceliron top—40 inches x 32 inches, 40 inches x 24 inches, as examples. Make the table first and put it in place in the nook, then the benches having a length of 44 inches over all, and distances that are usable to any size and weight of person using this furniture. The furniture may be enameled either white or blue.

Specialized Closets

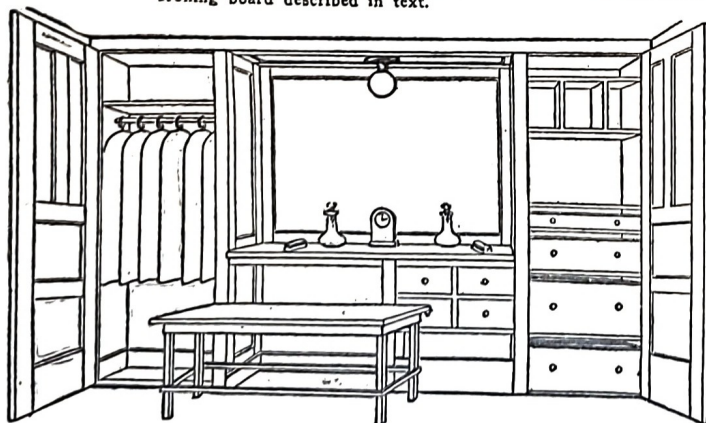
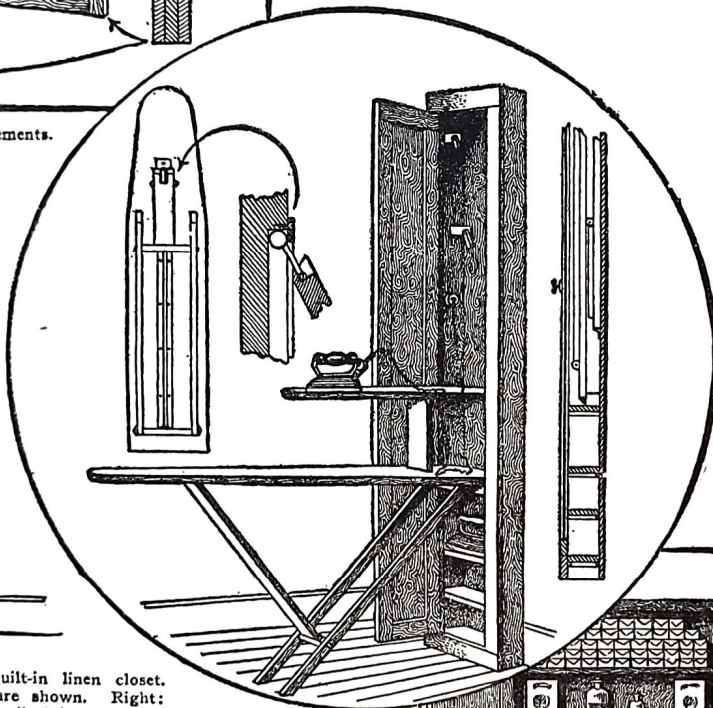
By W. M. BUTTERFIELD



Above: Closet for cleaning implements.



Above: View of a built-in linen closet. Drawers and shelves are shown. Right: Ironing board described in text.



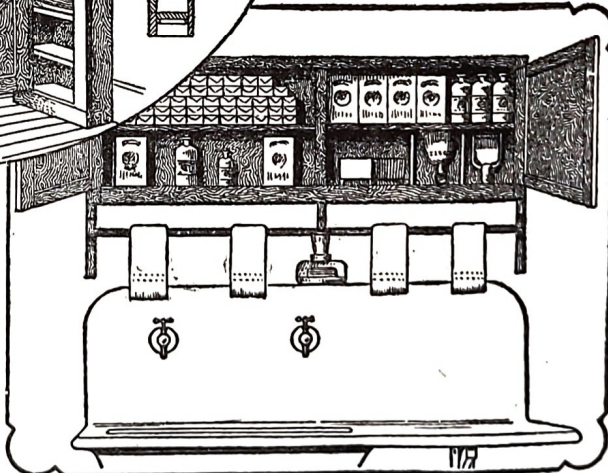
The illustration above shows two built-in closets with a dressing table and drawers placed between them. All should be constructed of the same kind of wood and stained to match. A bench completes the set.

THE first example shown is a closet large enough to hold the entire cleaning outfit of the household—vacuum cleaner, broom, mop, floor wax, furniture polish, etc. The closet has been designed for the kitchen, and is intended to occupy a space on one side of the kitchen cabinet, while another, of the same size and design, is planned for the other side to hold cooking utensils and for tinned food supplies. Panel board can be used in the construction of a closet of this kind for the back, the sides and the door.

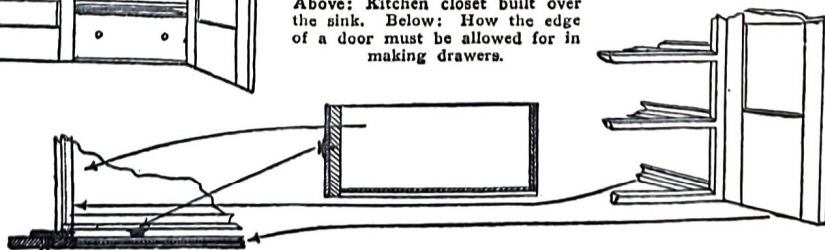
Another example shows a closet for the ironing boards as well as other implements used in ironing. One closet is for the kitchen sink outfit and is designed to occupy a space over the sink.

Every housewife wants a linen closet—many are willing to sacrifice one for clothes if they can only have one for linen. Answering this almost universal call of the housewife, we show a plan by which the sacrificed clothes closet can be converted into a bona-fide linen closet. In fact, this closet was designed for a storage place for linen, although it may have the outward appearance of the usual receptacle for clothes. A rather complicated design is shown in which dressing table and closets occupy one whole end of a bedroom. Specialization is shown here, also, for one closet is for outer garments, the other for under garments. There also are drawers for the usual dressing table supplies in the table and a box for shoes under the drawers. A neat bench is provided as part of this outfit. Mirrors are set in through sides above the table while an overhead electric fixture to supply illumination is installed.

In constructing drawers or drawer-like trays, in closets, it is necessary to provide for space for drawpulls and for space at the door side to pull the drawer out past the door. We have shown a series of detailed sketches to illustrate the requirements and one method of procedure. In the ironing board details, we have shown the most practical device for supporting the board yet devised. It consists of two folding members, one hinged to the board, the other fastened to the board by means of a T-shaped metal piece sliding in a long metal-covered groove in the board. This works automatically.



Above: Kitchen closet built over the sink. Below: How the edge of a door must be allowed for in making drawers.



Protections for Windows and Entrances

Beautifying the Home in a Simple and Practical Way

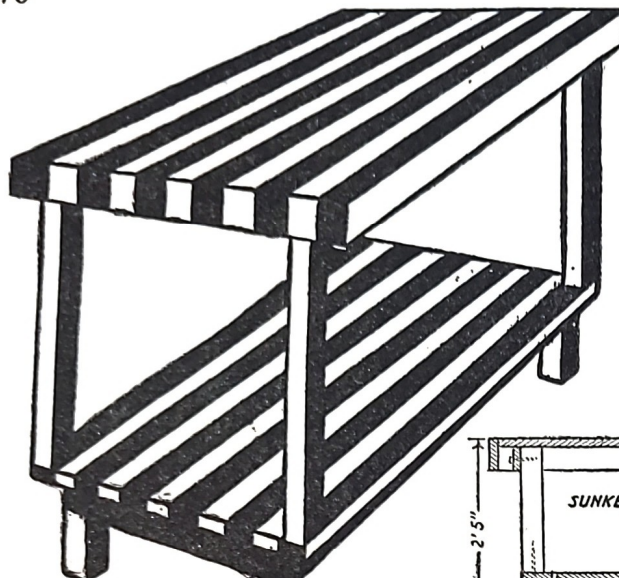
By WILLIAM M. BUTTERFIELD



It often happens, that some door or window in a new house is not sufficiently protected from the elements or from direct sunlight. In such an event, the home mechanic can, by exercising a little ingenuity and by carefully studying the drawings on this page, construct an artistic covering for one or more of these places. A roof over a side porch will protect a person while searching for the key or if constructed over a window will keep out the direct and blinding rays of the sun. The two drawings at the top of this page show how coverings of both of these types can be constructed and the small detailed drawings give all the information necessary. The tops of these small protections can be covered with canvas, shingles, copper or tin. The entire assembly can then be stained or painted any desired color. If the builder desires to go in for more elaborate construction, those drawings given to the left and below can be followed. Although they may appear difficult to carry out, still they are actual examples of home workmanship. Standard molding, trim and veneered sheets were utilized and were sawed into the various shapes or bent and nailed to enclosed rafter supports. The designs shown have all been constructed with the original door frames which they cover.

Cloth Covered Porch Furniture

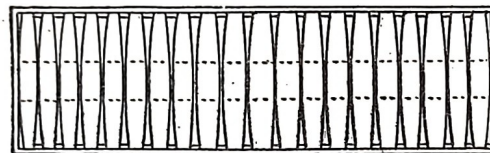
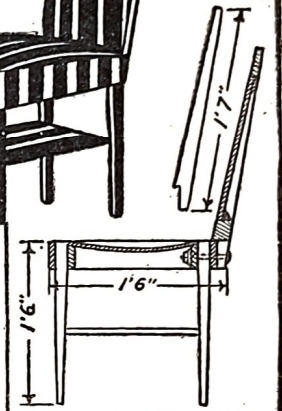
By WILLIAM BUTTERFIELD



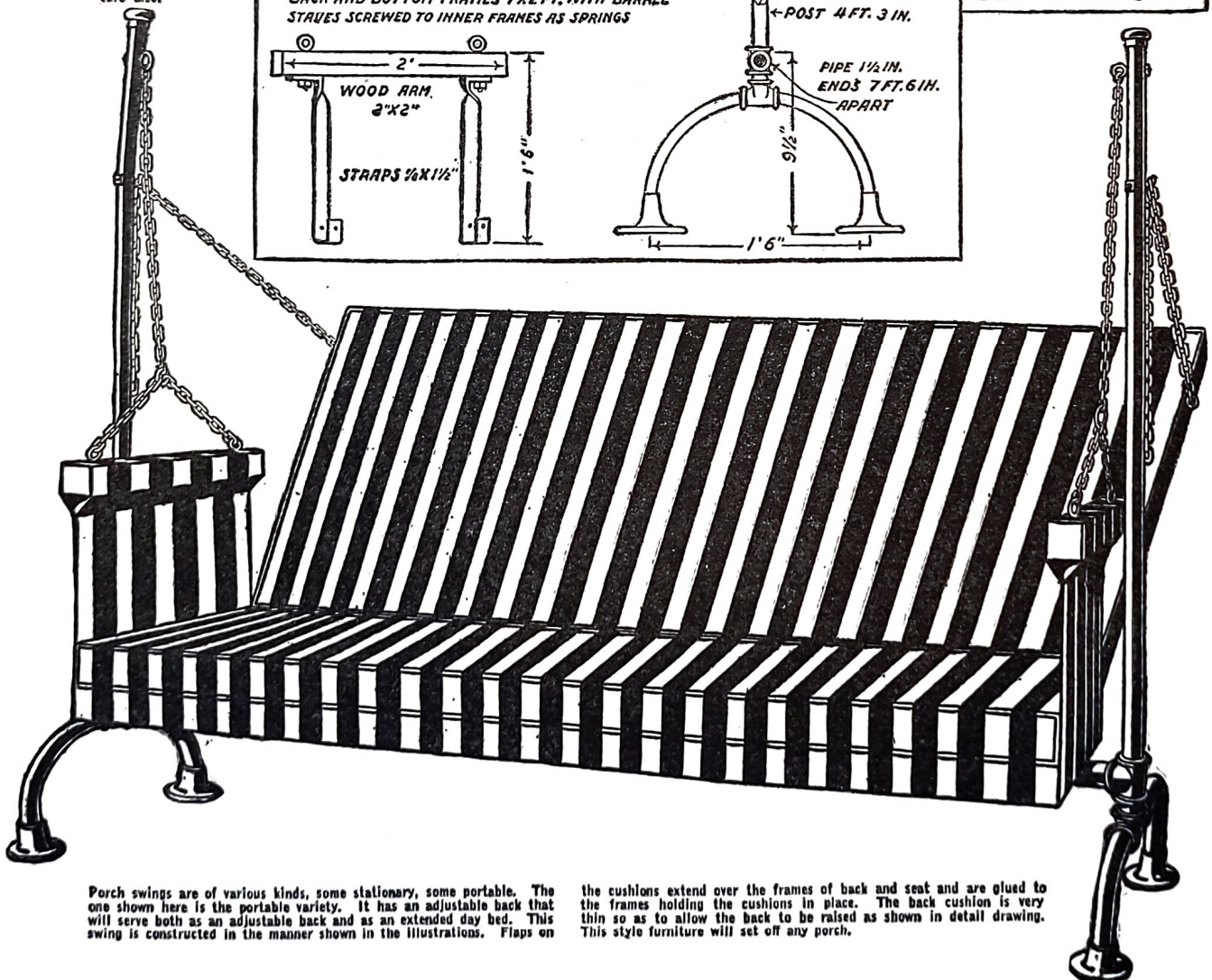
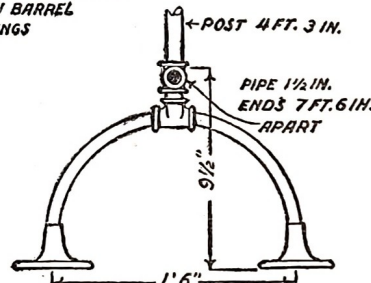
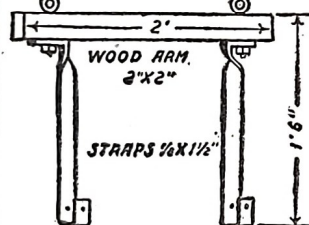
Furniture for the porch that is for the most part, if not completely, covered with cloth, is a novelty which is shown in our illustrations. A sunken leg table is the first shown. It can be of any convenient size, 2' 5" high, and with legs and posts 2"x2". The whole table can be made of soft wood. The cloth, which may be of awning canvas, is glued to the table.



A chair also covered with cloth, is next shown. It is 1' 6" high, with a back 1' 7" high. The seat is 1' 6" x 1' 5" with two frames holding the legs in place. The inner frame supports a springy seat bottom on which the stuffing or upholstery is supported. The back is made by using a large seat bottom made to fit as shown. Bolts hold the back. The cloth is glued on this piece of furniture also.



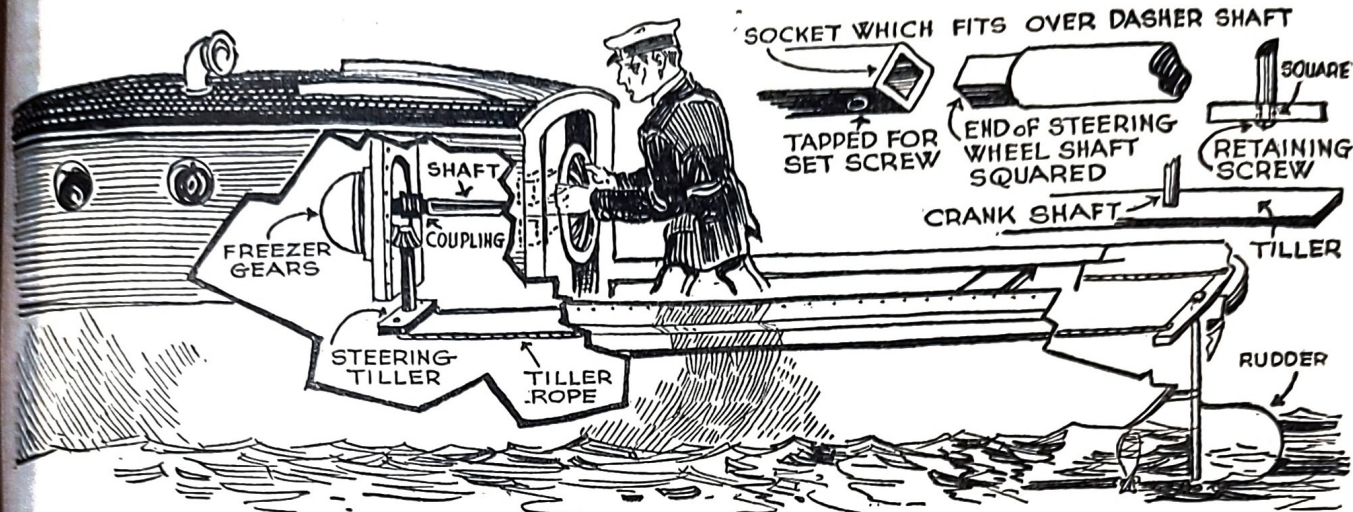
BACK AND BOTTOM FRAMES 7 X 2 FT. WITH BARREL STAVES SCREWED TO INNER FRAMES AS SPRINGS



Porch swings are of various kinds, some stationary, some portable. The one shown here is the portable variety. It has an adjustable back that will serve both as an adjustable back and as an extended day bed. This swing is constructed in the manner shown in the illustrations. Flaps on

the cushions extend over the frames of back and seat and are glued to the frames holding the cushions in place. The back cushion is very thin so as to allow the back to be raised as shown in detail drawing. This style furniture will set off any porch.

Boat Steering Apparatus

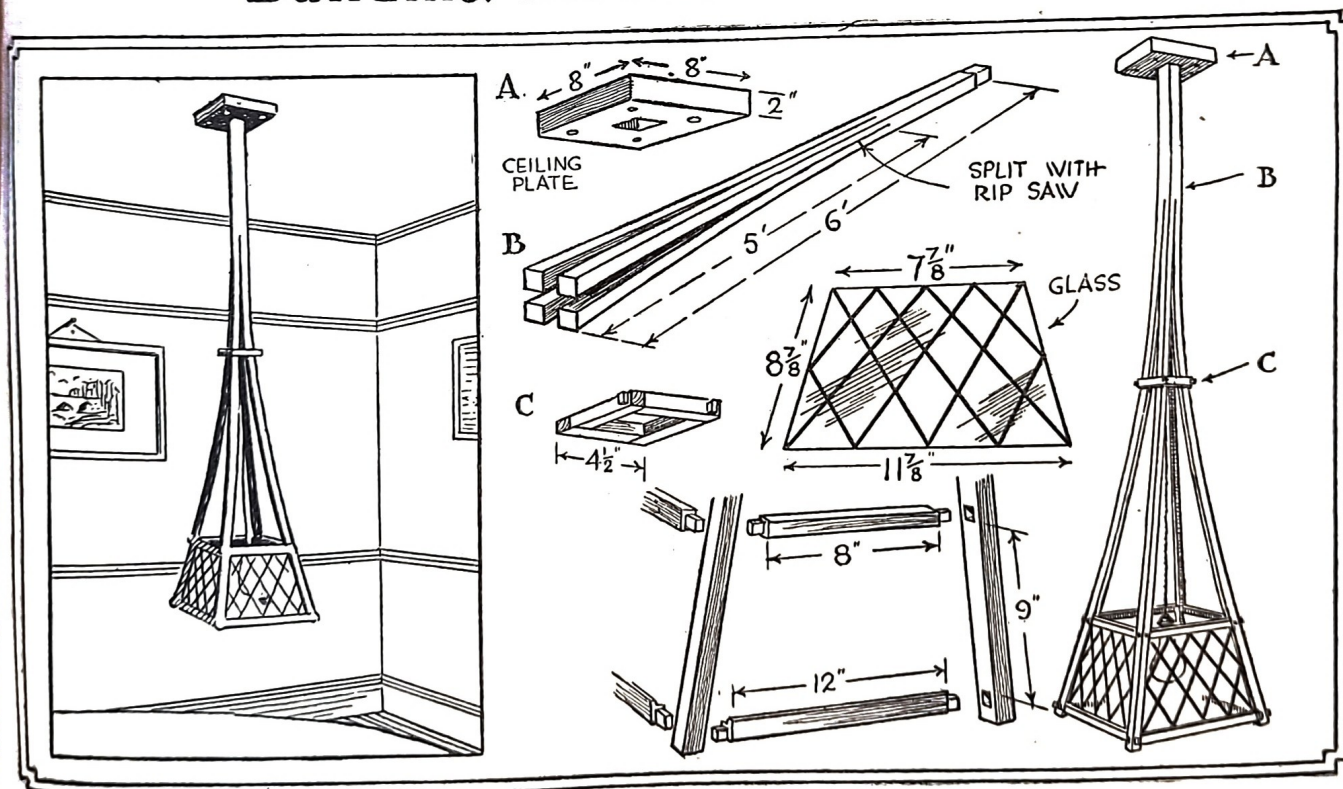


To give the small boat at least one appurtenance of a large cruiser it should be fitted with a regular steering wheel. This can be done easily and inexpensively by the method shown above in which an old ice cream freezer and an automobile steering wheel are used. The rudder is first fitted with a cross tiller to which are fastened two ropes. These pass along the gunwales into the bow. If the boat is decked forward, it is an easy matter to hide the ropes beneath

the deck. Remove the handle of the freezer from its crank-shaft and replace with a second tiller yoke having the same dimensions as the one on the rudder. Make this of metal with a square hole in the center and tap the end of the shaft for a retaining screw. Then provide a round iron rod with a squared end to fit the socket in the dasher gear of the freezer. Place and secure the wheel as shown. This will give the effect of a high speed racing boat.

—L. B. Robbins.

Building An Art Craft Lamp



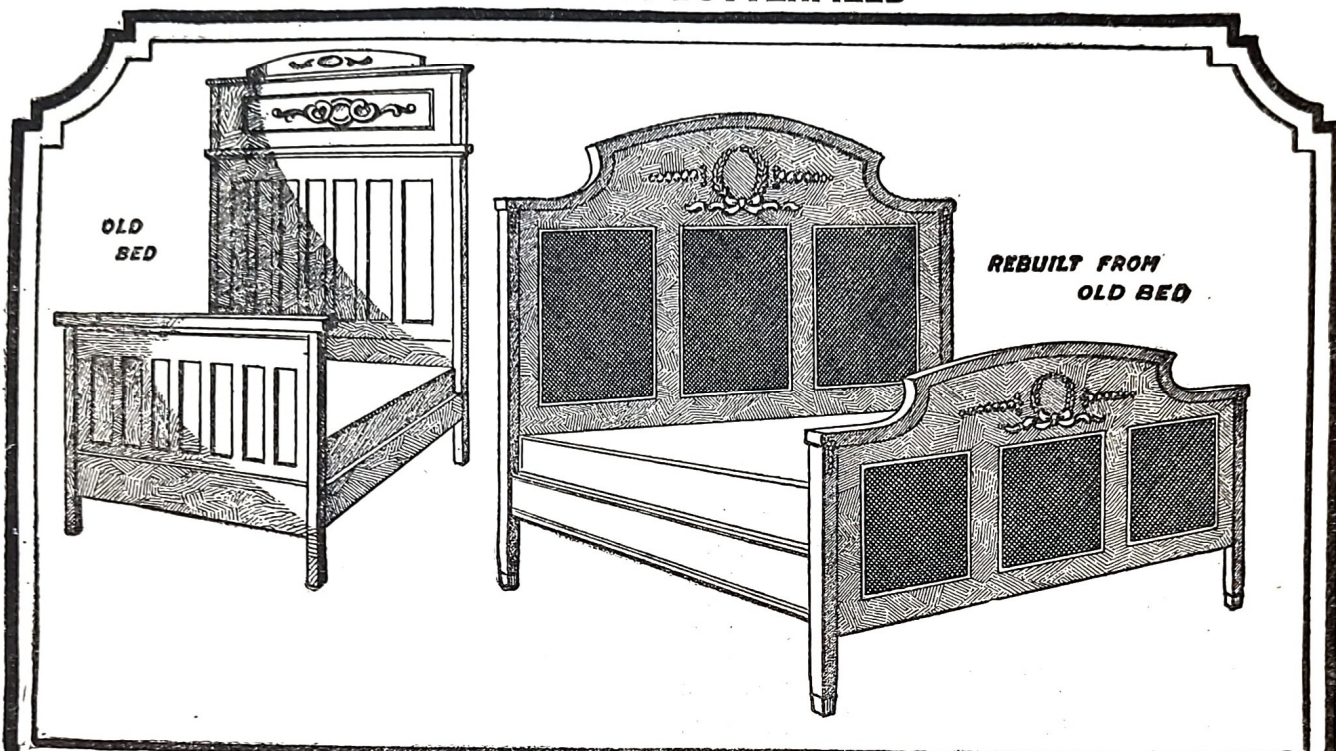
A straight grained piece of oak $1\frac{1}{2}$ inches square and 6 feet long should be ripped twice up the center with two cuts at right angles to each other for a distance of five feet. This piece forms the drop and four corner posts. The segment B, at the top is drilled down its center for the lamp cord. To hold the posts in proper relation, and in order to give the lamp its majestic curve—a binder, C, is made which is passed down on the frame. The lamp is held to the ceiling by means of

four screws and the block, A. After the wood has been cut, small blocks are placed between the strips so as to spread them apart. This facilitates the work of sandpapering the wooden pieces. The cross-pieces of the frame, eight in number, are rabbeted back one-quarter inch to hold the glass. Plain or colored glass lined with drop black and japan increase the beauty of the lamp. It will harmonize well with the favorite mission type furniture.

—J. T. Garver.

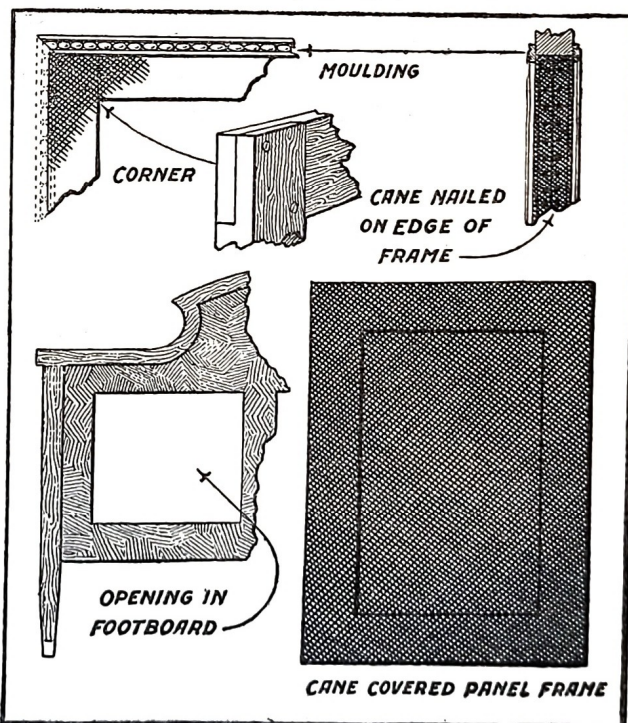
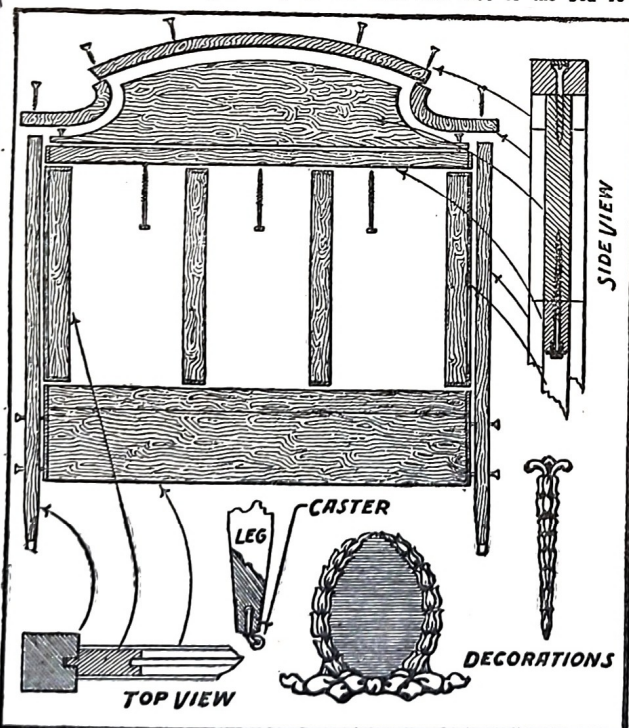
Home Mechanics

A Reconstructed Bedstead Having Cane Panels By WILLIAM BUTTERFIELD



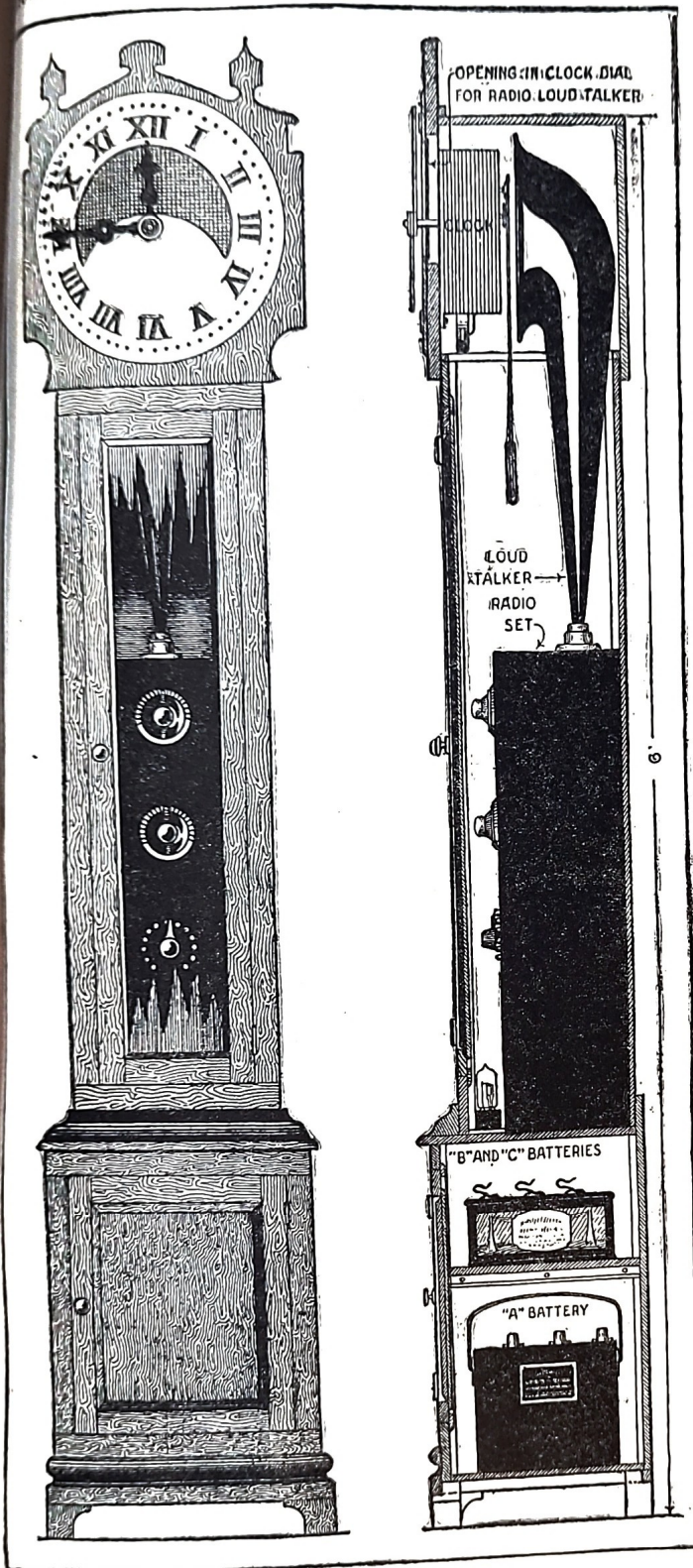
The drawings here show how an old walnut bed, discarded many years, was utilized as the skeleton for a modern type bed with cane panels, the aristocratic appearance of which is at once apparent from the picture above at the right. The only mill work was that required for the six curved sections forming the top of the head and foot of the bed re-

spectively. The wooden beading used to hold the cane panels in place and the imitation wood carving were obtained at a cabinet shop. The cane is obtainable by the yard and is machine braided. The cane is sometimes left plain or it may be varnished. If the builder is handy with tools he may make all the parts for the structure.



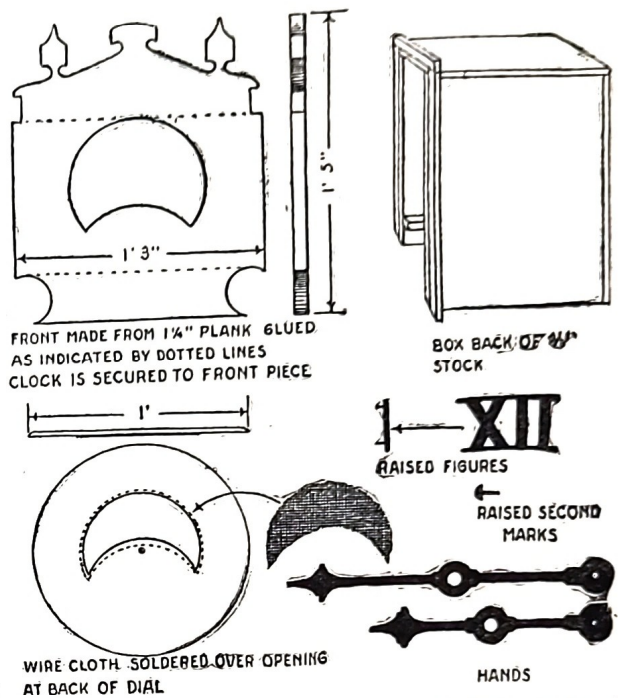
The drawings above show in detail how the head and foot of the bed were laid out and assembled. The details for the head and foot are identical. Each wooden leg was tapered and covered at the bottom with a brass cup, then fitted with a fiber roll caster. The parts of the old bed supplied the necessary tongue and groove sections for the new piece

of furniture. Wood screws and lag screws were used to aid in gluing as well as for added strength. The old varnish was softened with wood alcohol and removed with a wire brush; the bedstead was re-stained and varnished to represent mahogany. The cane is thoroughly dampened before tacking in place on the frames; it stretches tight when dry.



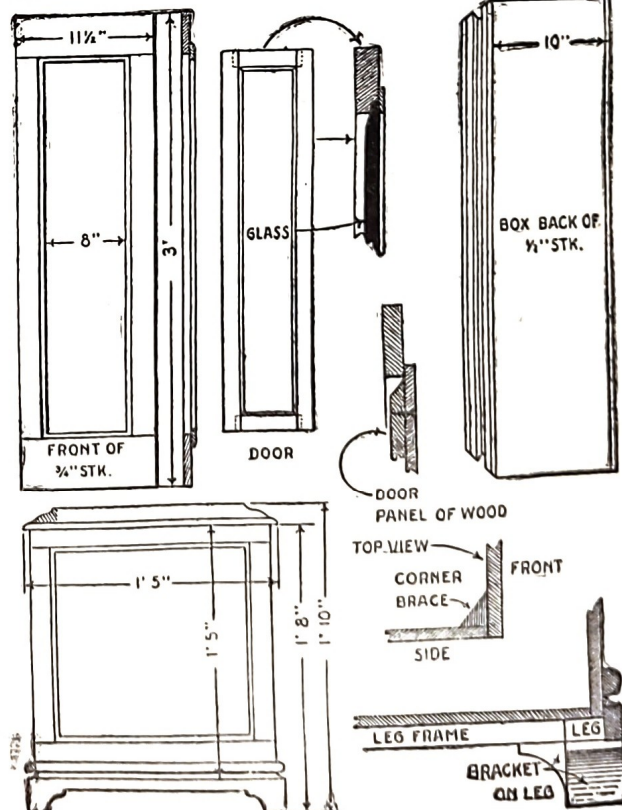
Home Mechanics

Putting the Radio Set in Grandfather's Clock



Above is shown in detail the construction methods for the top of the clock. The front is composed of two or three separate pieces glued together to give the necessary width. The box to contain the clock is fairly simple. Note the brackets for fastening the front to it. The dial may be of brass or copper, with a few coats of enamel. The numbers may be procured at almost any hardware store and are enameled black. The same is the case with the hands. The numbers and minute marks are fastened to the dial with pins as shown. The wire cloth outlet for the loud speaker is soldered to the rear of the dial.

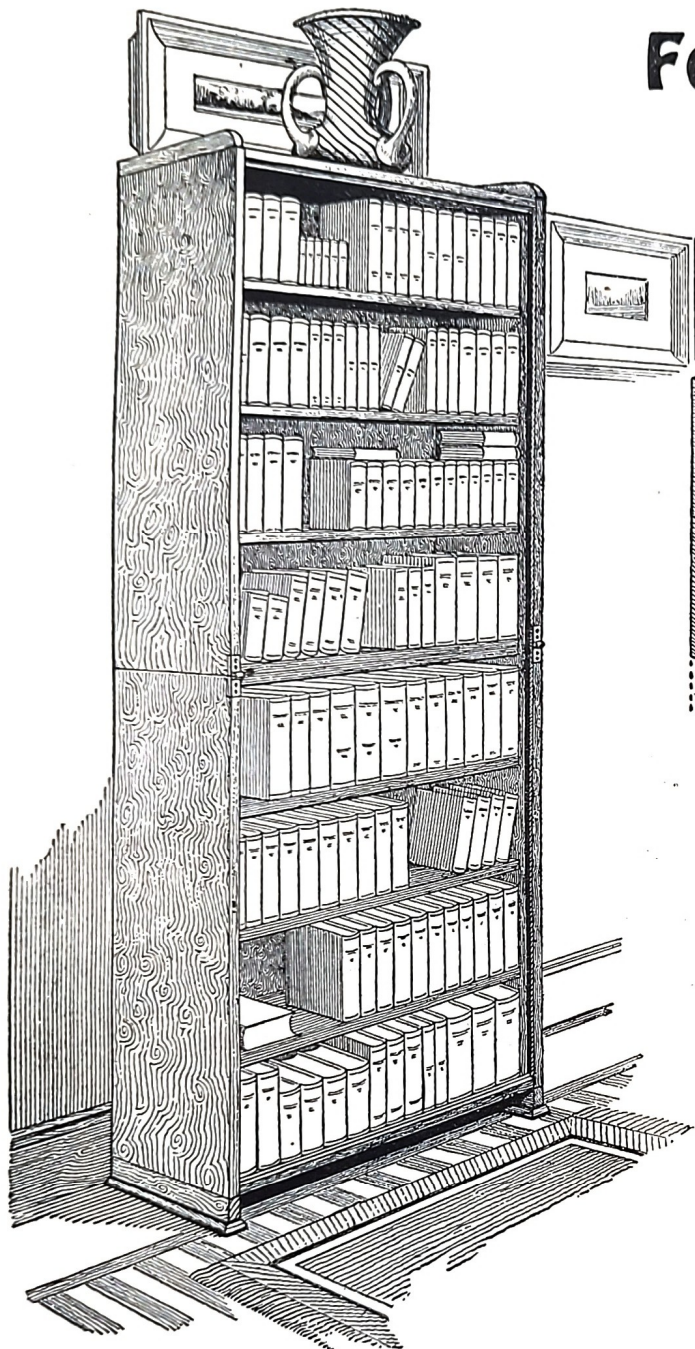
—William Butterfield.



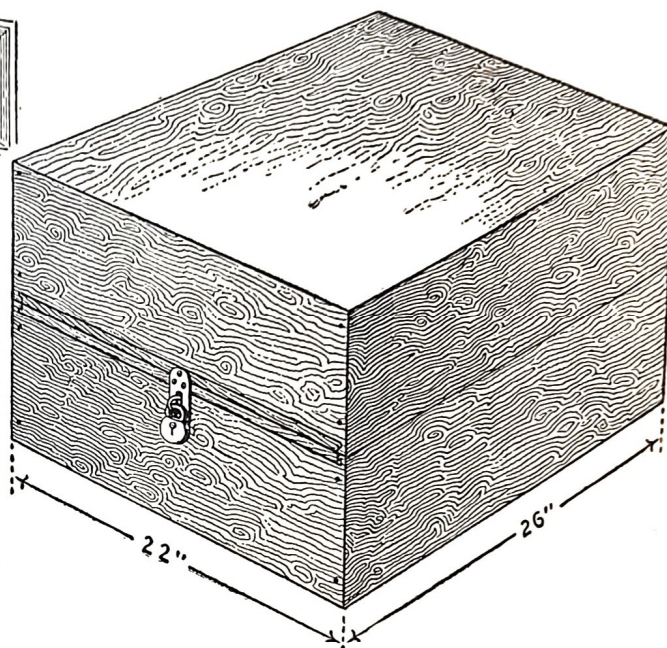
The furnishings of no home are complete without a Grandfather's Clock. One of the best adaptations for it is the installation of the radio set in the clock but also illustrations here not only show how to place the radio set in the clock but also show how to construct the clock itself. Directly above is contained in the top, the elevation of the complete piece. The clock work is contained in the pedestal. The radio set proper is installed in the pedestal and the batteries necessary for operating the set are placed in the bottom. The radio cabinet and the horn delivers the loud speaker is placed on the top of the radio cabinet. The actual design of the radio cabinet must be such that it will leave room for the clock case, which must set evenly on end and be held fast to the back of the clock case. Details for the construction of the pedestal and base of the clock case are shown at the right. All trim used is standard and may be obtained at any lumber yard. It will be found best to use walnut or oak throughout, though other woods will serve. The completed piece may be finished in any style to suit the builder. All joints should be tongue and groove style and should be glued. Likewise the corner braces should be glued and tacked. Heavy ordinary glass or beveled edge plate glass may be used for the pedestal door.

Folding Bookcase

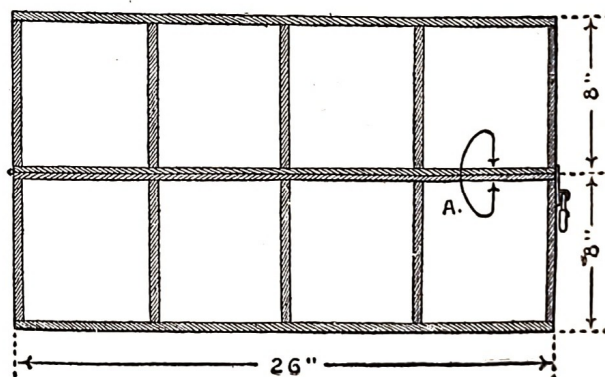
By G. H. WAETJEN



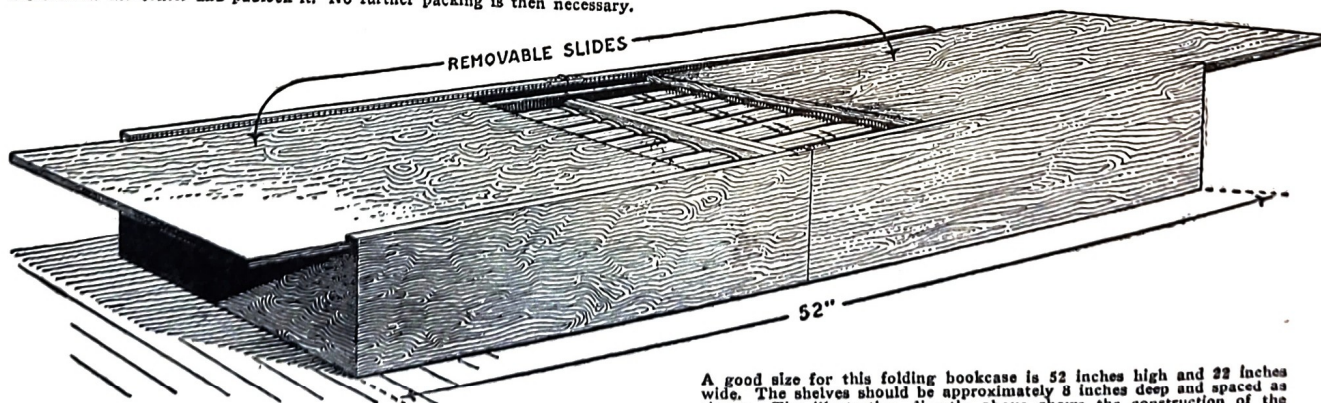
This new folding bookcase may be readily built by anyone at all handy with a saw and hammer. It may be built of any material, although oak is preferable and it may be stained to match any furniture in the room for which it is intended. In the type illustrated, eight shelves are provided and the entire case is hinged in the middle. When moving, insert the slides, fold the case in the center and padlock it. No further packing is then necessary.



Although folding furniture of various designs is by no means new, here is one piece that differs considerably from the usual run. With this bookcase, it is not necessary to remove the volumes from the shelf when folded up as shown. Slides prevent the contents from shifting.



Above is shown a cross sectional view of this bookcase when folded for shipment. The removal slides indicated by A, amply protect the contents and prevent the books from becoming mixed up during moving.



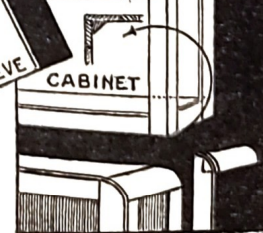
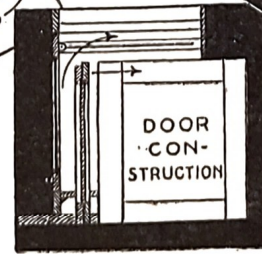
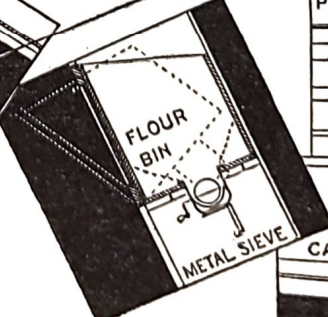
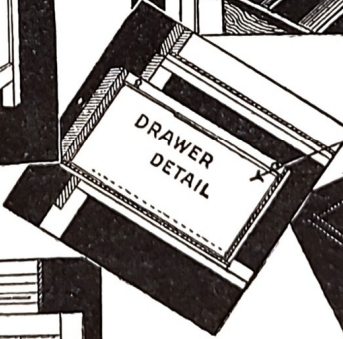
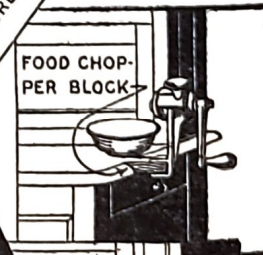
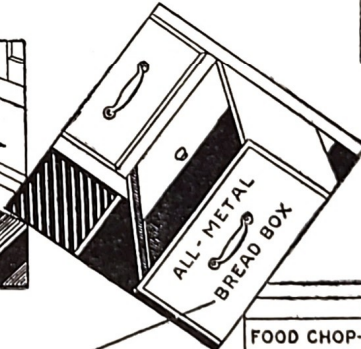
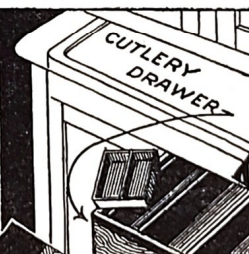
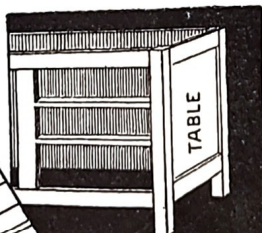
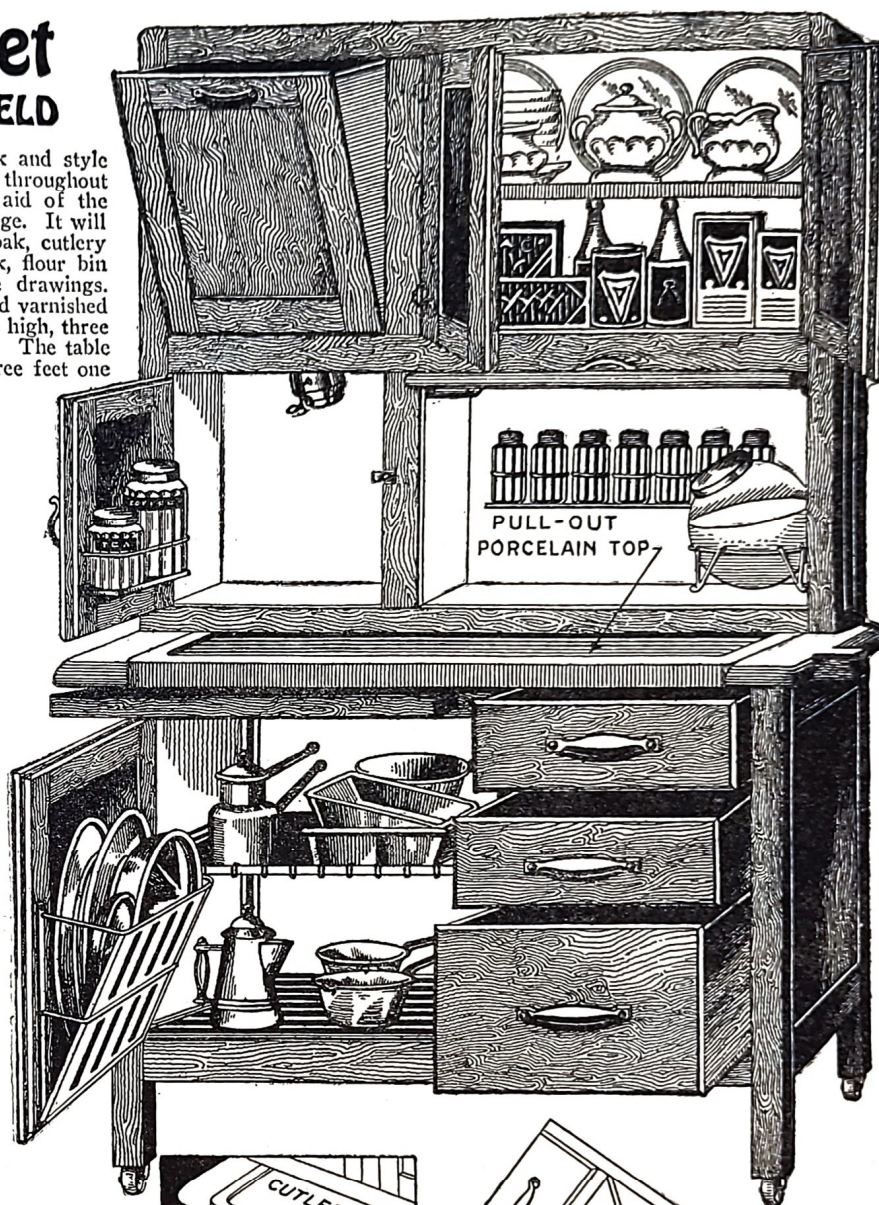
A good size for this folding bookcase is 52 inches high and 22 inches wide. The shelves should be approximately 8 inches deep and spaced as shown. The illustration directly above shows the construction of the grooves for the removable slides which protect the contents.

Kitchen Cabinet

By WILLIAM M. BUTTERFIELD

A KITCHEN cabinet that will have the look and style of nearly every cabinet sold anywhere throughout the country can be home built with the aid of the details and perspective drawings shown on this page. It will have a pull-out porcelain top, cutting board of oak, cutlery drawer, all metal bread box, food chopper block, flour bin and many other conveniences suggested by the drawings. The cabinet can be made of hard or soft wood and varnished or enameled. The cabinet is five feet eight inches high, three feet six inches wide and two feet one inch deep. The table is two feet seven inches high. The cabinet is three feet one inch in height. The cupboard and drawer spaces are made in proportions about as shown, no definite sizes are given.

Porcelain fittings can be obtained in many colors and styles—their holding shelves or racks are of course made to fit the style selected. The sugar jar shown here is an improvised, glass aquarium with its holding rack, a metal top of convenient size is used to cover the jar. The metal shelf and trays for the utensil cupboard are made of copper and then enameled. The flour bin is made of wood with a common commercial metal sifter fitted in the bottom as shown in detail. The sifter will require an extra piece of metal soldered at the top to connect it to the bin, and a cap hinged at the bottom to close that opening when not in use. The bin and sifter should be so constructed that by tilting forward the bin can be removed from its cupboard like a drawer. The all metal bread box is an ordinary sliding top box placed in a drawer built to fit it. This box will probably determine the size of the drawers. One of the cupboard doors is made for convenience to open sectional-book-case-style by sliding vertically into a slot. The ordinary book case metal fittings are used to secure the door. The oak cutting board is attached to the cabinet in the manner employed with extension tables on an office desk. A block of hard wood (oak) is fitted in a groove with screws as shown to hold the food chopper when in use. Draw pulls, hinges and fastenings for the doors and castors are easily obtained from the large variety of such hardware on the market. In fact it is possible to obtain almost all the metal, glass or porcelain material used in the cabinet from regular commercial stocks.

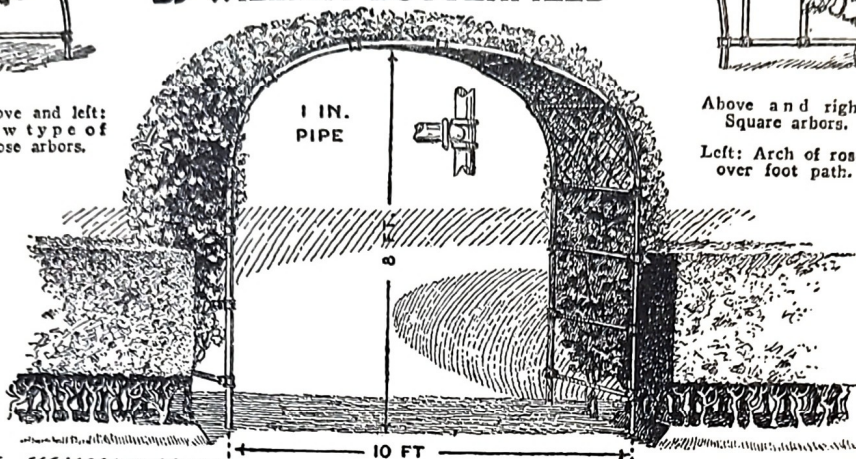
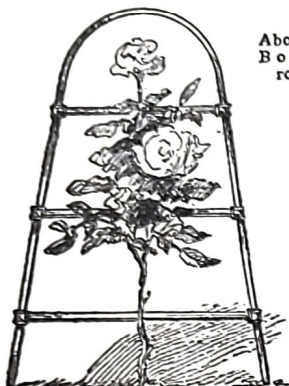


Rose Arbors

By WILLIAM BUTTERFIELD

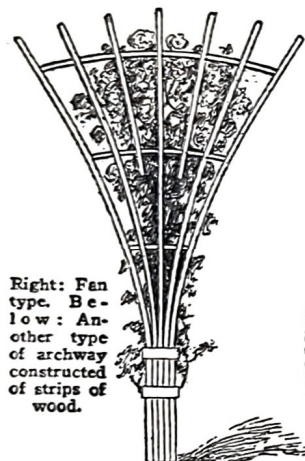
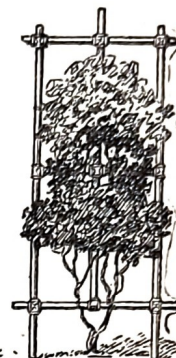
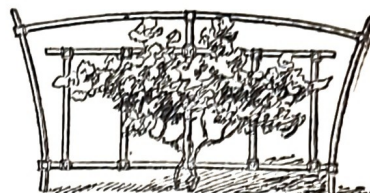


Above and left:
Bow type of
rose arbors.

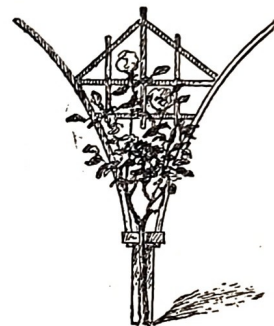
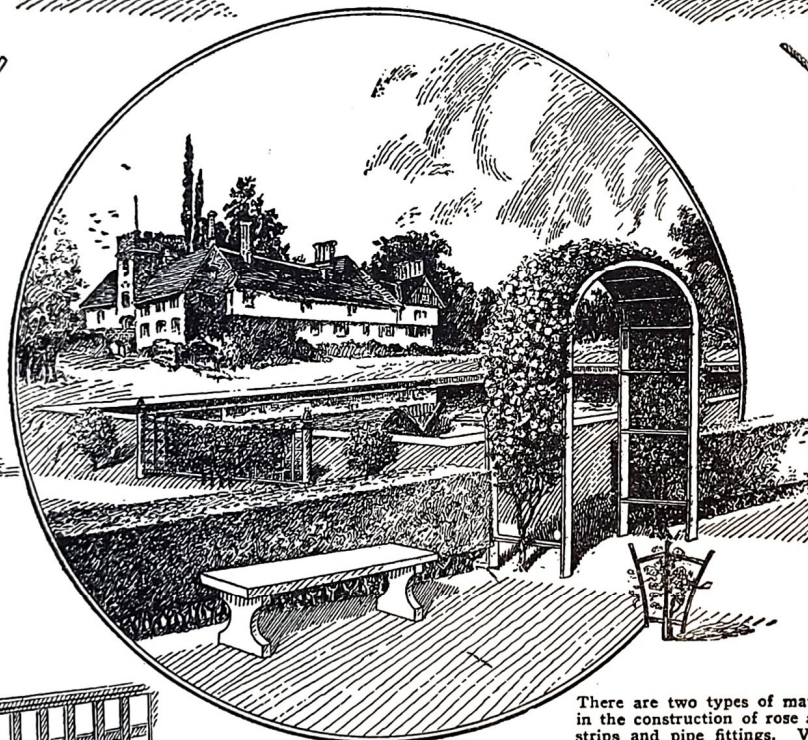


Above and right:
Square arbors.

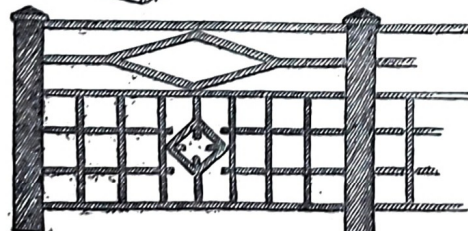
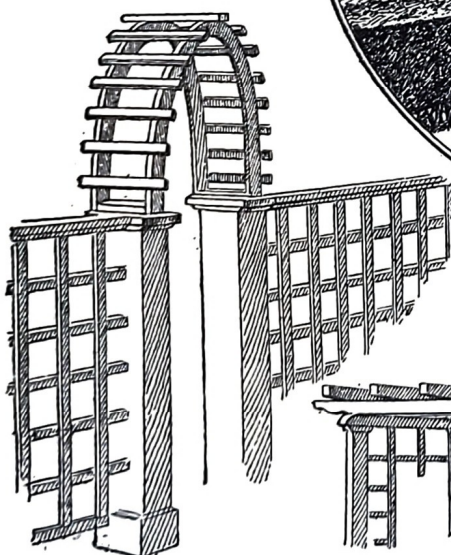
Left: Arch of roses
over foot path.



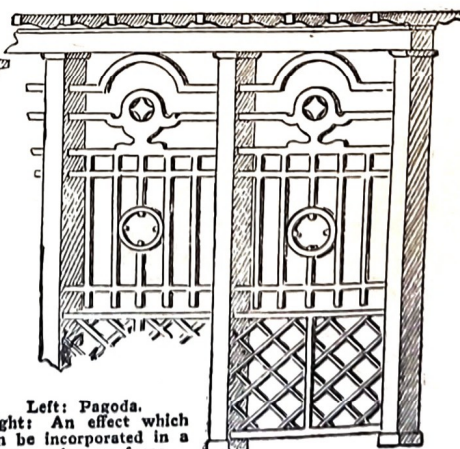
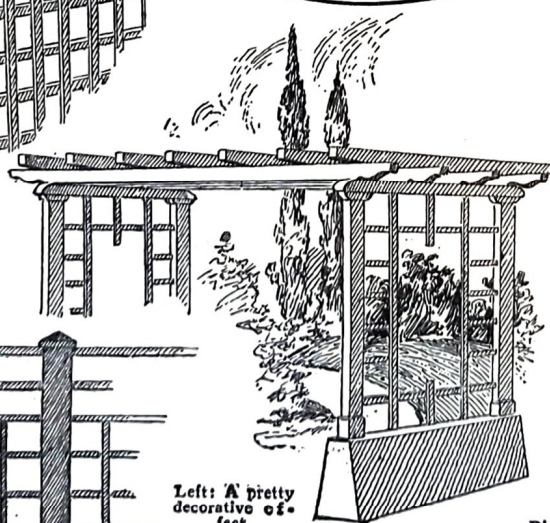
Right: Fan
type. Be-
low: An-
other type
of archway
constructed
of strips of
wood.



Above: An-
other type of
fan - shaped
trellis.



Left: A pretty
decorative ef-
fect.

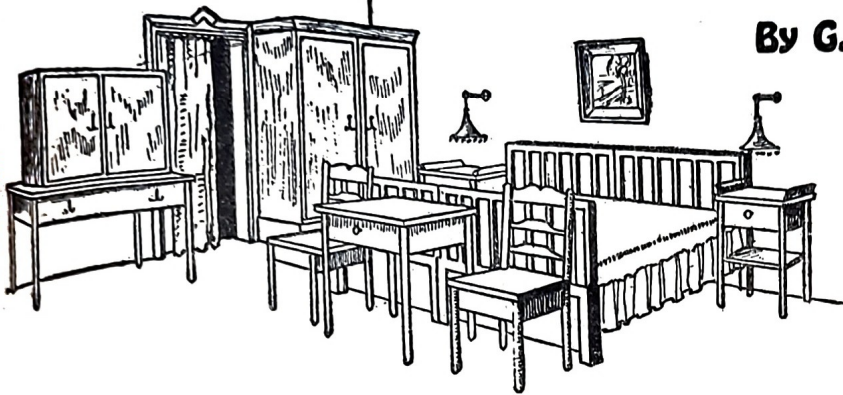


Left: Pagoda.
Right: An effect which
can be incorporated in a
gate, arbor or fence.

There are two types of materials which may be used in the construction of rose arbors. These are wooden strips and pipe fittings. Various details of different types are shown on this page. A very pretty arbor, the frame of which is made from pipe fittings, is shown at top center. A similar type, but of wooden construction, is shown in the center.

Portable Bed-Room Outfit

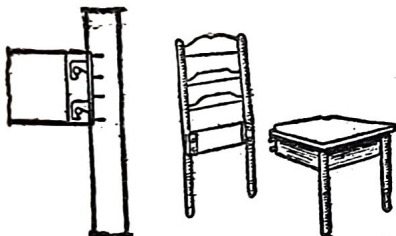
By G. H. WAETJEN



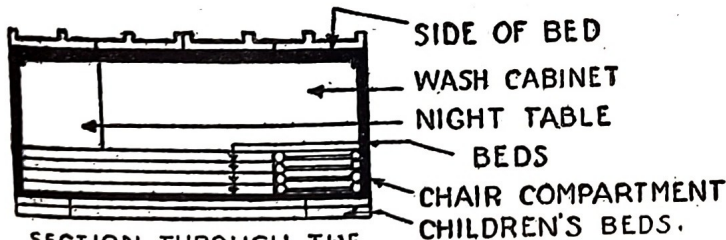
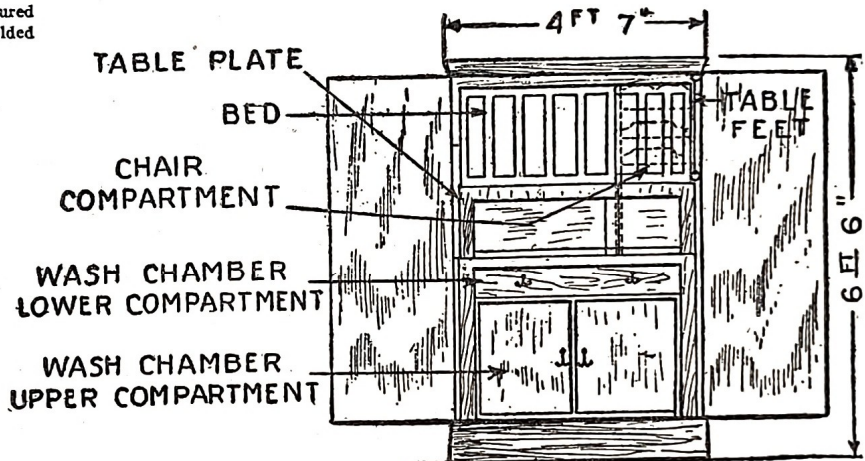
— THE ROOM OPENED UP —
CLOTHES-CLOSET
WASH-CABINET
BED (ACCOMODATING 4 PERSONS)
NIGHT-TABLE
TABLE
CHAIRS

THE FOLDING ROOM OPENED, READY TO LIVE IN.

The illustration directly above shows what appears to be an old fashioned bed-room suite constructed from solid oak and complete in every detail. This suite, however, manufactured by an Austrian concern, is capable of being completely folded and fitted together in a very small space.

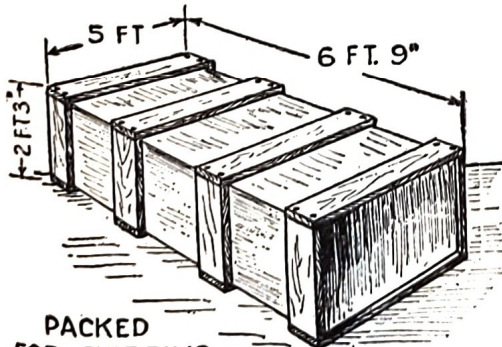


THE CHAIR



SECTION THROUGH THE CLOTHES-CLOSET

A side section view of the clothes closet is shown above. Note how each section of each piece of furniture fits in a definite place. The entire suite when so folded and packed for shipment occupies the dimensions given below.



PACKED FOR SHIPPING
THE WHOLE ROOM ENCLOSED IN THESE DIMENSIONS

THE CLOTHES-CLOSET OPENED, SHOWING FURNITURE INSIDE

Above is shown how all of the furniture comprising this bed-room suite fits into the clothes closet after having been disassembled. The illustration to the left indicates the method of fastening the parts of the various pieces of furniture together. When assembled, the articles are very rigid and look exactly like ordinary furniture.



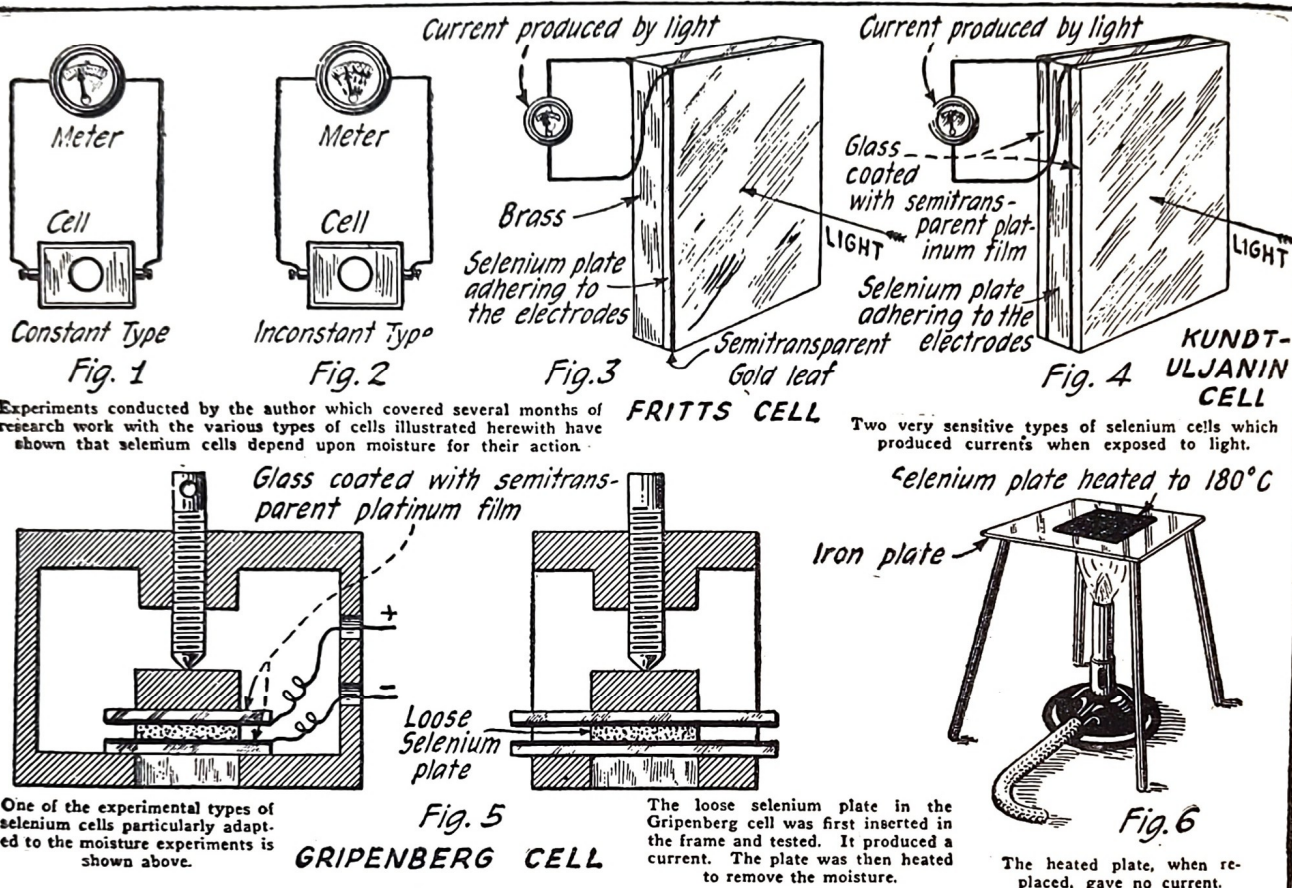
— THE BED —
PROVIDING ROOM FOR TWO PEOPLE; OR FOR CHILDREN OR GUESTS

When guests arrive, sleeping space for two additional people may be provided by the auxillary beds that are enclosed within the regular bed as shown above. This extra bed is only four inches smaller than the other.

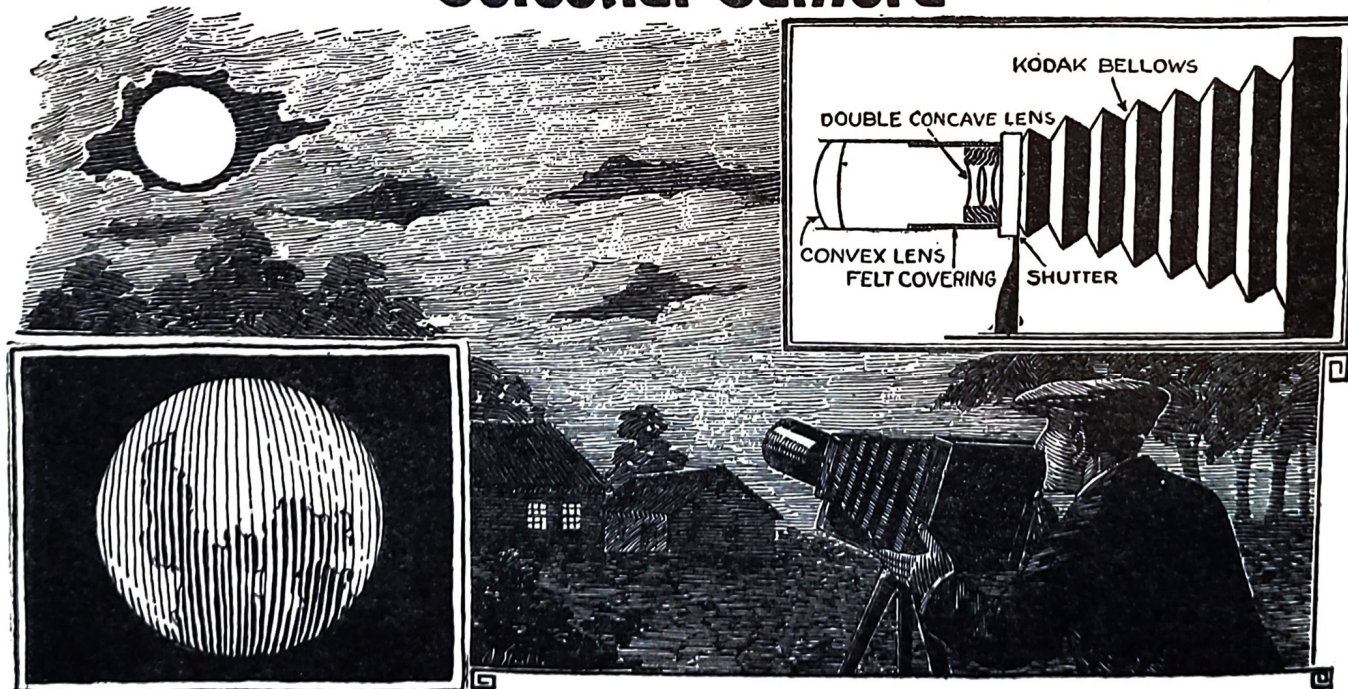
Current-Producing Selenium Cells

Their Dependence On Moisture.

By W. S. GRIPENBERG, Selenium Cell Specialist



Celestial Camera



A camera attachment for taking photographs of the heavenly bodies may readily be made as shown above. A tube with a focusing arrangement is first provided and fitted at one end with a convex lens. A double concave

lens is placed in the other end in the manner shown. By setting the camera on a rigid tripod, focusing and experimenting with the length of exposure, excellent results can be obtained. Left—moon.—C. B. Johnson.

Construction of a Gasoline Blow-Pipe

By FRED W. DIXON

HOW often have you wished for a fine pointed, hot flame that could be operated in any direction? Doubtless many times. You had the soldering iron ready but it was too clumsy to get at the work, or lost its heat too rapidly. The blast lamp gave too large a flame, while the alcohol lamp wouldn't reach the spot, and there you were "stuck," or else you had to make a job that did not suit you.

The blow-pipe described here is a very efficient type. It gives a fine, hot, pointed flame, that may be made large or small as desired, and may be operated in any direction. Its construction is quite within the capabilities of any amateur experimenter, and the old, reliable "junk box" is sure to have something to contribute to its manufacture.

This blow-pipe will be found excellent for ordinary soldering, soldering pipes in automobile radiators, building up lead terminals on storage cells, melting sealing compound around battery jars, light brazing, and other innumerable uses.

The essential parts are a source of compressed air, the carburetor or vaporizer, and the nozzle.

The air supply may be the same as is used for

The Gasoline Blow-Pipe here illustrated is of very efficient type and gives a fine hot, pointed flame that may be made large or small as desired. Furthermore, the flame may be thrown in any direction. The constructional details of this blow-pipe are quite within the capabilities of any amateur experimenter, and it will be found very excellent, indeed, for ordinary soldering, repairing automobile radiators, building up lead terminals on storage cells, melting sealing compound on battery jars, light brazing, and many other uses.

inflating tires, that is a compressed air tank, or a small tank may be obtained to hold a moderate pressure. The pressure required is not great, as five pounds pressure in a tank will run it satisfactorily; of course the tank used should hold more than this pressure, else the tank will soon be empty of air.

The carburetor is constructed according to the diagram. The case consists of an ordinary pint jar with straight walls as shown. A plate, preferably of brass, is cut to fit on the top and thru this three holes are drilled. In one hole a tube is soldered, which runs to the bottom of the jar. This tube should have an internal diameter of about one-eighth inch. On the other hole, diagonally opposite, is soldered an elbow, and on the center hole, a priming cock. Underneath the brass plate is placed a cork gasket which is shellacked, so that, when the rim is screwed down, it will seal the brass plate on the jar, thus preventing air from leaking out. The pipe, going to the bottom of the jar, is connected to the air supply, the elbow connects to the nozzle, and the priming cock is used to pour the gasoline into the vaporizer. The gasoline should have its level about two-thirds of the way up in the jar. This constitutes the vaporizer.

The nozzle presents more difficulties than the carburetor, but by carefully following the drawing its design is easily understood. The handle is made by using a bicycle pump, of the type having a short metal cylinder,

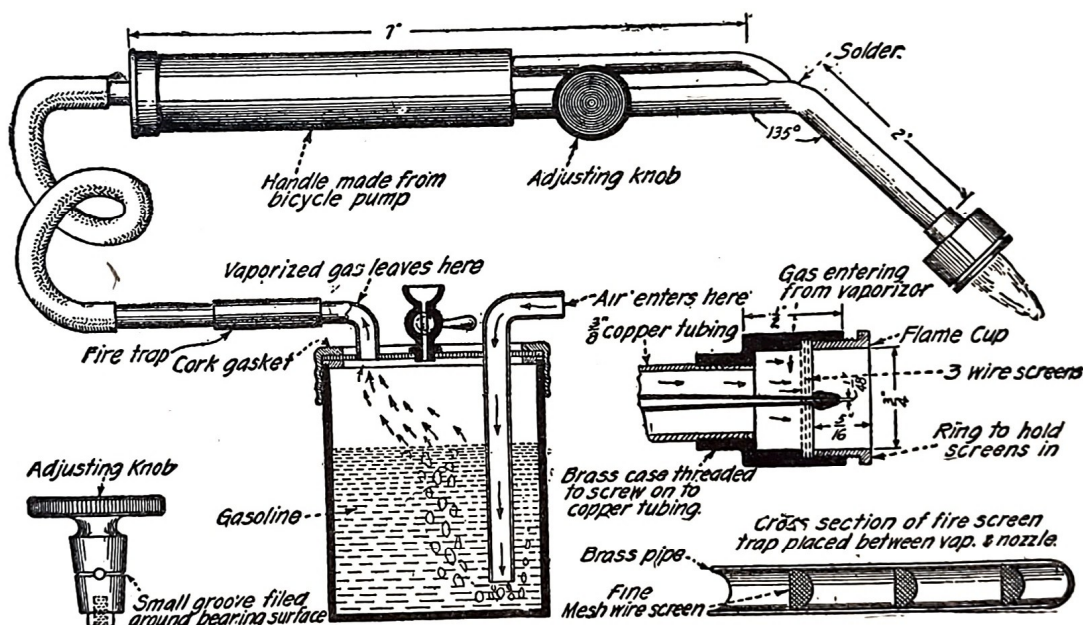
and only the cylinder and end cap are used. The end cap, which screws on, has a tube soldered into it and this is connected to the carburetor for the entrance of the gas. Into the other end of the cylinder two pipes are to be soldered.

The bottom pipe is the larger and is made of three-eighths inch tubing. Copper tubing is preferable as it is easier to bend. In bending the tubing, one end should be tightly corked, and then the tubing filled full of tightly packed sand, after which the other end is corked. The tube can now be bent without flattening at the bend. The angle of the bend should be about 135 degrees. The lengths of the tubes are shown in the diagram.

At the end of the handle and connecting with this large tube is a small pet-cock, which is fixed in this manner. The screw is removed and the inner part taken out. Using a small three cornered file, file a small groove no deeper than the thickness of a pin connecting the two holes around the bearing

obtained from places dealing in scientific supplies. They are used by jewelers and also for performing blow-pipe tests on minerals. An ordinary pipe may be used if a suitable tip can be fitted on. The hole in the end of this should be about 1/48 inch in diameter or the size of an ordinary pin. This small pipe enters the interior of the lower and larger pipe at the angle, and is soldered there. The end with the tip projects thru the interior of the larger pipe into the flame cup, and its end is just above the wire screens.

The advantages of this type of blow-pipe are its ease and simplicity in operation, its cheapness, its ability to operate in any direction, and the fact that there is no waiting as in the ordinary blast lamp—you simply turn on the air and light the gas at the nozzle. The pet-cock on the larger pipe controls the size of the flame which may be varied from a pencil point to one as large as a blast lamp. A grade of gasoline, of fairly high volatility, should be used, or else in



surface, and all the way around. This allows some gas to pass the tap even when it is set closed.

The construction of the flame end is best studied from a diagram. The cup-shaped end has a diameter of three-fourths inch and is constructed of brass on the lathe unless the "junk" box yields something. If it is threaded so that it can be screwed on, it facilitates matters should cleaning be necessary.

Three screens are used in this flame cup, the first being of the type where small holes are punched thru thin metal discs—the other two screens are of fine brass of 50 or 60 mesh or thereabouts. The number of screens is obtained by experimenting, it depending on the smallness of the mesh of the wire. The upper ring shoves in tightly against the case and holds the screens in place.

Between the vaporizer and the nozzle it is generally advisable to place a fire screen or trap of the design shown. This removes dirt, and eliminates any tendency for fire to go back and ignite the gasoline at the vaporizer.

The top pipe coming from the cylinder is an ordinary mouth blow-pipe—it may be

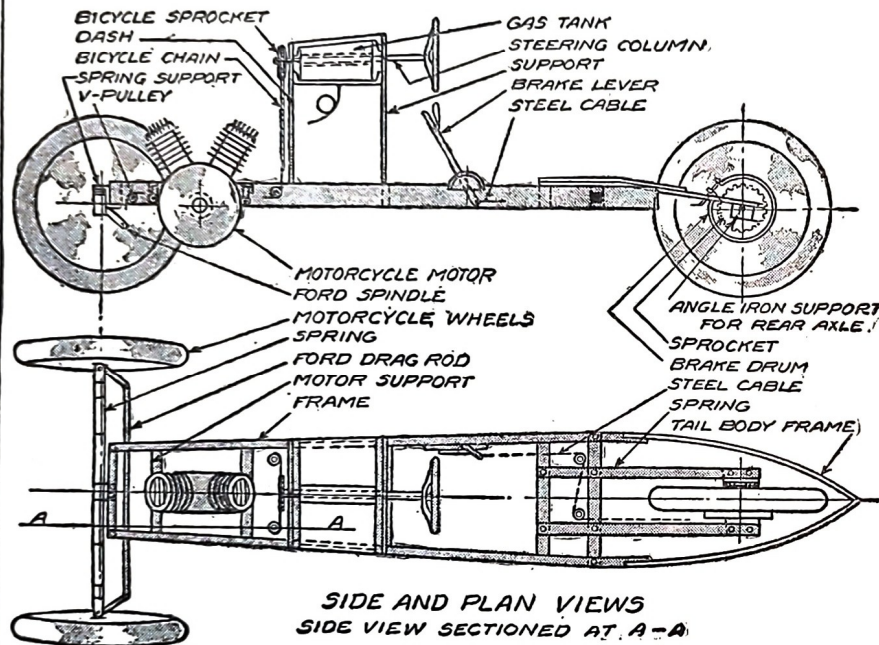
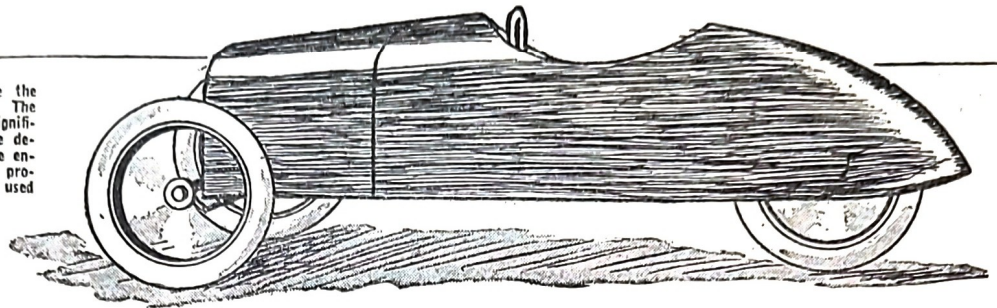
the poorer grade, the volatile parts vaporize, leaving the less volatile portion which collects in the vaporizer giving a poor flame. In case low test gas is used this almost non-volatile part should be removed and fresh gasoline substituted. The rubber tubing, obtained at the drug store, for connecting the parts, is best selected with thick walls to prevent kinking.

While this gasoline blow-pipe may be constructed from various odds and ends to be found about the work shop or in the usual odd-parts box, it will be much more efficient all around undoubtedly, if the various parts are made as carefully as possible and of good materials. The burner nozzle for example, could very well be constructed by a machinist and the cost would be within reason. Another part that can very well be made of metal instead of glass, is the carburetor or vaporizing chamber. A metal chamber is preferable to a glass one, as there is then no danger whatever of breakage. The valves or pet-cocks can be purchased at most hardware stores or steam fitting and plumbing supply house, also. The rubber tubing required can be purchased at drug stores or chemical supply houses.

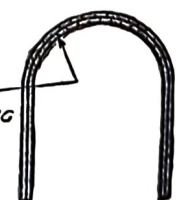
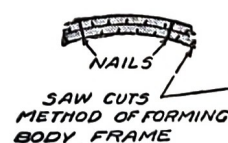
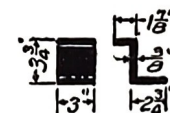
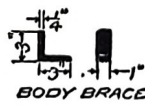
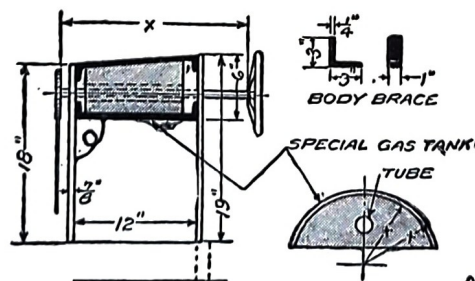
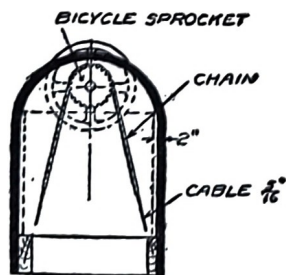
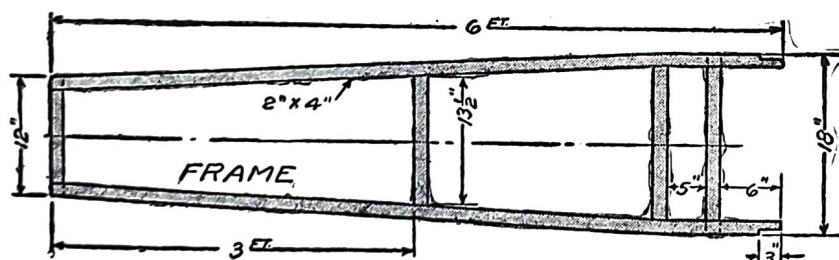
Easily Constructed Cycle Car

Motorcycle Engine and Wheels Used. No Fine Work Necessary
By GALEN BARBER

An auto speedster that will tickle the heart of young men everywhere. The cost of building the machine is insignificant compared to the pleasure to be derived from such a car. A motorcycle engine supplies the necessary power for propelling the car. Ford parts can be used on many sections of the speedster.



SIDE AND PLAN VIEWS
SIDE VIEW SECTIONED AT A-A



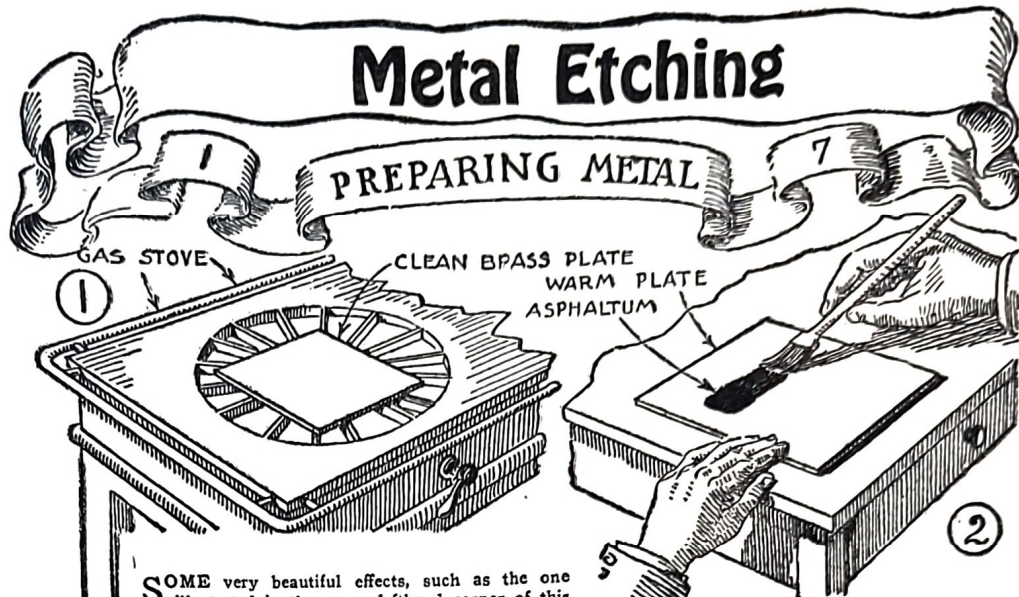
NOTE—"X" INDICATES DIMENSIONS WHICH MUST BE DETERMINED TO SUIT MATERIALS AVAILABLE.

Although the three wheeled motor car has not come into use in this country, it has achieved great popularity in Europe. The construction is so simple that any amateur craftsman may undertake the building of it. The wheels and engine are motorcycle parts. The frame is of ash or oak, well seasoned and firmly braced at the corners. The stringers and cross pieces are mortised and tenoned. The corner braces are made of malleable steel. Stock spring steel cut to shape form the springs which

are attached to the frame with bolts and yokes. The front wheel spindles are Ford parts and must be turned to suit the wheels used. The connecting or drag rod must be bent to clear the frame. The steering gear is built with a bicycle sprocket and chain with steel cable. The dimensions given in the drawings will fit for the most part. However, many changes may be made to suit the builder. The gas tank will have to be specially made. Interpose motorcycle clutch and chain drive.

Metal Etching

PREPARING METAL



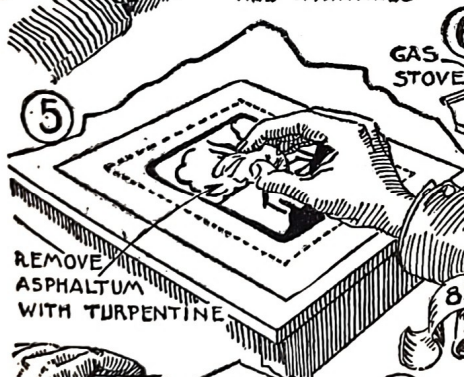
SOME very beautiful effects, such as the one illustrated in the upper left-hand corner of this page, may be obtained by properly etching and filling copper plates. The procedure is illustrated herewith. (1) A clean brass plate of the desired size is warmed over a gas flame and (2) coated with asphaltum. Then, (3) a sheet of lead foil is smoothed out over the brass plate and, (4) a design is traced on the foil and the parts to be etched are cut away with a very sharp knife. A cloth saturated with turpentine is then used to remove the asphaltum, (5). A composition is then made, (6) and a ring formed of the mixture around the part to be etched, (7). An acid solution (8) is then made up and poured into the space formed by the ring, care being taken that the plate is level. The acid is left on until the copper plate is sufficiently etched. This length of time must be determined by experiment. The acid is then washed off with warm water, the foil removed and the asphaltum taken off by moistening it with turpentine and scraping. The plate is then ready for the filling of the etched portion.

TRACE DESIGN WITH HARD PENCIL AND CUT OUT FOIL WITH SHARP KNIFE

ASPHALTUM COVERED BRASS PLATE

LEAD FOIL

SMOOTH OUT ALL WRINKLES



REMOVE ASPHALTUM WITH TURPENTINE

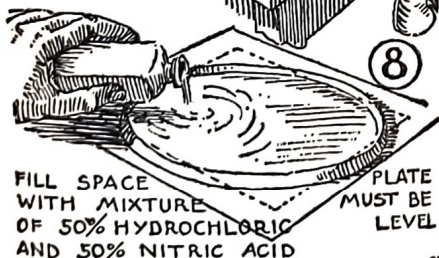
GAS STOVE

6

SIMMER TOGETHER:
2 OZ. YELLOW BEESWAX
2 1/2 OZ. PINE RESIN
1 OZ. TALLOW
1/2 OZ. TURPENTINE
AND KEEP FLAME LOW

RING 1" HIGH FORMED OF MIXTURE MADE AS IN 6 AFTER COOLING

ETCHING



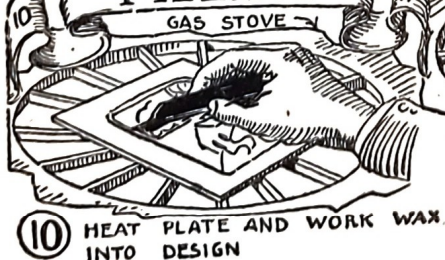
FILL SPACE WITH MIXTURE OF 50% HYDROCHLORIC AND 50% NITRIC ACID

PLATE MUST BE LEVEL

GAS STOVE

8

FILLING



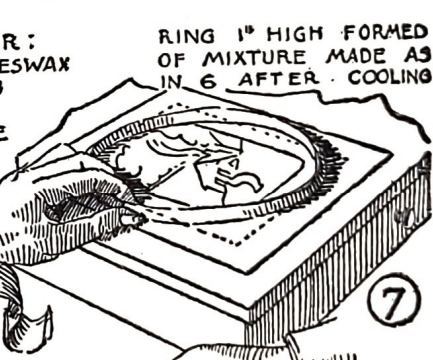
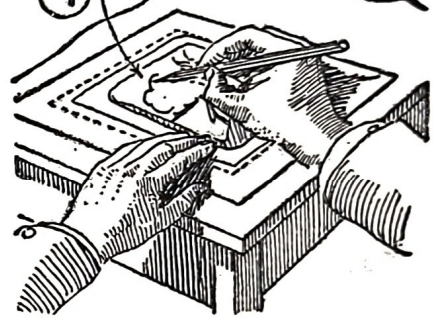
HEAT PLATE AND WORK WAX INTO DESIGN

GAS STOVE

10

11

SCRAPE OFF EXCESS WAX WITH EDGE OF CARDBOARD OR FLEXIBLE KNIFE



WASH ACID OFF AND REMOVE TIN FOIL. MOISTEN ASPHALTUM WITH TURPENTINE AND CAREFULLY SCRAPE OFF

FINISHING



DIP PLATE IN ETCHING SOLUTION. REMOVE, COVER WITH TABLE SALT AND SCRUB WITH BRUSH

To fill the etched plate, heat it, (10) and work sealing wax into the design. In place of sealing wax, a filler composed of "patent dryer" thoroughly mixed with dry color may be used. Scrape off the excess wax, (11) with a piece of cardboard or preferably a flexible steel knife. A pleasing effect can be put on the plate (12) by covering the plate with etching solution, after which salt is applied and the surface thoroughly scrubbed.

—Joseph Crotty.

Motorcycle Engined Monoplane

By WILLIAM J. BEACH

(WHO HAS BUILT AND FLOWN AIRPLANES OF THIS TYPE)

THE monoplane herewith illustrated and described has been designed expressly for a two-cylinder motorcycle engine developing 12 to 16 H. P., which power will permit of a cruising speed of 50 to 55 M. P. H. while a maximum speed of 62 M. P. H. may be attained.

The design and general arrangement is the simplest possible, thus enabling those who already possess some knowledge of airplanes and of the handling of tools to construct it.

The cost of this machine, less the motor, should not exceed \$65.00 (sixty-five dollars). With reference to the motor the writer would suggest that a racing type, over-head valve motor be used if such can be procured.

The first parts to be made are the wing beams which consist of three pieces of clear, straight-grained spruce, $1\frac{3}{4}$ " thick, placed vertically, having pieces 3" by $\frac{5}{8}$ " extending along top and bottom, glued and screwed, thus forming I-beams as shown in Figs. 4, 5 and 6. The beams are held apart by solid compression ribs from which points the bracing cables are attached, the said cables should be of heavy steel wire.

The ribs are cut to fit the I-beams and lightened as in Fig. 5, all ribs and intermediate nose pieces are made from white pine $\frac{1}{8}$ " thick having capping pieces $\frac{5}{8}$ " by $\frac{1}{8}$ ", top and bottom secured with glue and brads.

Figs. 4 and 5 show the method of fixing both the leading and trailing edges.

Hard-wood blocks are fitted at points where the beam braces, bolt holes for the diagonal struts, beam plates and aileron hinges are located.

Before covering the wings the aileron control guides and cables should be placed in position.

The ailerons, elevators, etc., are made by

forming a box section and allowing the rib members to enter the same as illustrated in Figs. 4 and 12.

The fuselage is made from 1" square spruce (tapered towards the tail ends) having vertical and cross members as in Figs. 7 and 8; all are braced with steel wire, using automobile spokes shortened and converted into turn-buckles.

The method of securing the vertical and cross members to the longerons is similar to that employed in the earlier days of the art, and is suggested in this particular instance, due to its simplicity which is clearly presented in Figs. 13 and 14. To get the clips thru the ends of the vertical and cross pieces a $\frac{1}{8}$ " slot is made which is again filled with a wooden block after the clips are in position; the ends are bored and provided with dowel pins, the points of which are received by a recess formed in the longeron; it is obvious that one clip must be larger than the other to prevent interference in passing thru the longeron.

The tail skid as shown in Fig. 11 is made from oak and pivoted on a 1" tubular transverse member.

The blocks shown in Figs. 9 and 10 are secured at their respective positions in the fuselage for attaching the wings to; these blocks should be made from two boards glued and dowelled together to obtain the maximum of strength, after which they may be lightened as shown.

The diagonal struts are of spruce 1" and $\frac{1}{2}$ " thick, streamlined and provided with suitable metal fittings at each end for bolting to the wing beams and fuselage.

The deck piece forming the cock-pit is of veneer reinforced with spruce strips on the under side.

The under-carriage is made from two pieces of spruce glued together and having a suitably shaped piece of metal sandwiched and bolted between the two pieces

of spruce, at and immediately above the slot in which the $1\frac{1}{4}$ " axle is located and provided with the usual rubber cord shock absorbers; the under-carriage is streamlined, likewise the axle if desired.

The wheels are standard 26" by $2\frac{1}{2}$ " and may be discd with fabric or tin to reduce head resistance.

The controls may be operated by the usual stick method, or a wheel may be employed, as the builder prefers.

All surfaces and fuselage are covered with a suitable fabric; a good quality of unbleached muslin will answer the purpose admirably. Irish linen or standard airplane cloth is used on commercial airplane wings.

In covering the wings the cloth should be sewn to the ribs and a reinforcing strip placed over each rib and along the leading edge.

All covered surfaces are given four (4) coats of airplane dope, then spar varnished.

An aluminum cowling is arranged around the nose of the fuselage and provided with louvres and an air duct as is shown in Figs. 1, 2 and 3.

The wings are set at an angle of three degrees of incidence, while no dihedral is necessary with this particular depth, curve and camber aerofoil.

The engine is provided with propeller five feet in diameter and of three and one-half foot pitch, which will take this little monoplane into the air without any difficulty and allow him who would fly to wing his way.

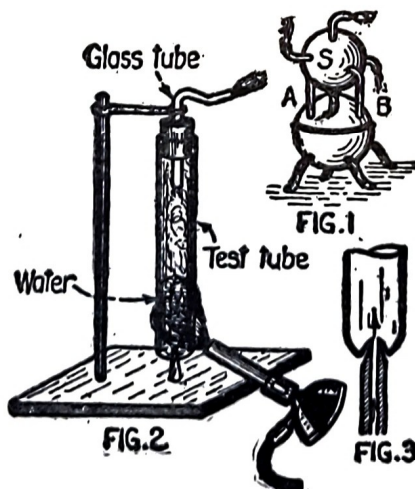
Those interested in building a small passenger carrying monoplane of the type here described, will find a great deal of additional information in some of the modern textbooks available at your library, and also by reading the aviation magazines available on the newsstands, in which suitable engines are advertised.

A Modern Hero's Steam Engine

One of the very earliest forms of steam engines is known as the Aeolipile or Hero's Steam Engine. It dates back to about 130 B.C. The original form is shown in Fig. 1. Water is heated in the boiler and the steam thus generated passes thru the pipes A and B into the sphere S. The reaction of the escaping steam gives the sphere a continuous circular motion as the radiating pipes retreat from the escaping steam.

The modern form of Hero's Steam Engine can be made with a test tube, and a short piece of glass tubing. The bottom of the test tube is heated in a Bunsen burner flame and pushed in slightly with the pointed end of a nail. This makes a pivot for the test tube to rest upon. The short piece of glass tubing is bent forming two right angles in different planes, and the end drawn to a point. It is then inserted in the test tube thru a one-hole stopper. The arrangement is then set up as shown in Fig. 2. The test tube is filled about one-third full of water and heated with a Bunsen burner. The reaction of the escaping steam causes it to rotate very rapidly.

This device can be modified by drilling a small hole in the bottom of the test tube.

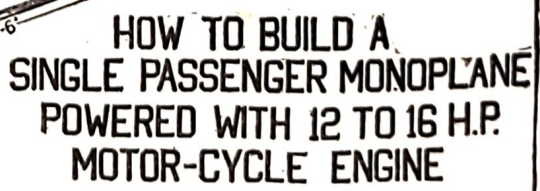


It is then arranged to rest lightly on a glass tube of suitable size thru which steam is passed from a boiler. A small brass cylinder similar to a small bicycle

One of the very earliest forms of prime movers—Hero's steam engine. It dates back to about 130 B. C. The original form is shown in Fig. 1. Water is heated in the boiler and the steam thus generated passes thru the pipes A and B into the sphere S. The reaction of the escaping steam gives the sphere a continuous circular motion as the radiating pipes retreat from the escaping steam. A modern form of Hero's steam turbine can be made with a glass test tube and a short piece of glass tube bent to form two right angles, as shown in Fig. 2. The test tube rotates on a point resting in a depression made in the bottom of the tube. Fig. 3 shows how compressed air or steam from a separate boiler may be passed up into the test tube, from a hollow point and hole in the base of the tube.

pump works just as well and a hole can be drilled in it easier than a test tube. If sufficient gas pressure is available it will operate with gas. The gas can be lighted and a very brilliant effect produced.

Contributed by F. C. HENDERSHOT.



Linen or Standard Airplane Cloth. The Propeller May be Purchased at a Reasonable Cost from Airplane Manufacturing Companies or Specialty Concerns Making Propellers. It is Preferable to Use a New Gasoline Engine, as an Old Motor May Cause Trouble, Once the Machine is in Flight, by Missing Fire or Otherwise Giving Trouble. Stranded Steel Cables Should be Used for All the Controls. Motor-Cycle Wheels May be Used on the Landing Gear.

Building A Buried

By VICTOR

Treasure Finder

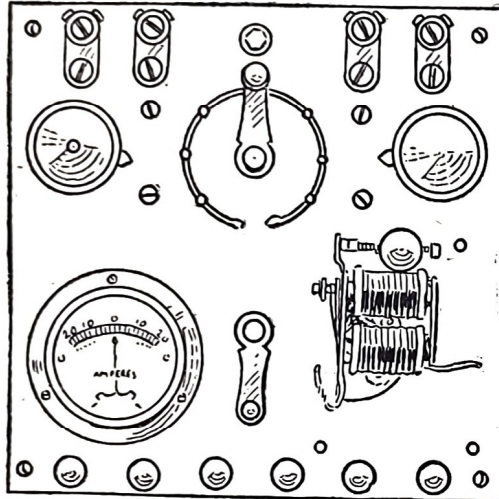
H. TODD

THE first requisites in constructing this apparatus are a good supply of patience and the ability to make good soldered connections. There are two circuits which must be absolutely identical under normal conditions and any difference such as is caused by one circuit coming under the influence of buried metal is detected by a differential current transformer. Consequently there must be no loose joints in



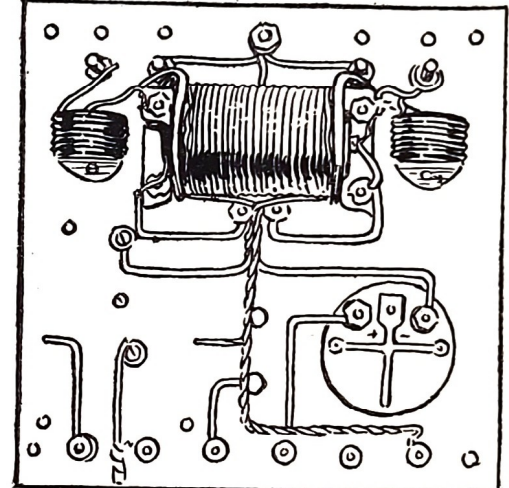
turns varied accordingly, and the insulation may be enameled, silk or cotton, as available. Solder a 12" length of fine lamp cord to the end and anchor securely at several places. Wrap a layer of bookbinder's cloth around the coil to give it a finished appearance.

Now on a temporary mandrel, wind two heavy wires, about .064 (No. 14), in parallel so that they will slide snugly into the secondary tube.



The photograph at the left, Fig. 3, shows a top view of the switch panel inside the cabinet, the buzzer-interrupter, ammeter and control switches being clearly shown.

The rear view of the switch control panel is shown at the right, Fig. 7.



either circuit. They must be perfect. There must not be one or two turns or feet of wire in one circuit more or less than the other. They must be identical.

With these points in mind and the ability to do a workmanlike job we can commence construction. For the two large exploring coils, we must build a mould made by nailing $\frac{3}{4}$ inch boards in two layers, with the grain at right angles, so that they form a block 2 ft. x 2 ft. x $1\frac{1}{2}$ inch thick. Out of this, cut a 2 foot diam. circle or leave the mould square as desired. Now nail more thin boards on one side to project $\frac{1}{2}$ inch all around the edge and the same on the other side, except that this side is attached with screws. Fig. 1 shows the mould and the method of winding.

The coils may be wound with any size of copper wire from .064 (No. 14) to .101 (No. 10) with any insulation such as enameled, single or double cotton, and the turns from 60 to 100, winding in even layers according to the size of wire used. But both coils must be identical in turns, size of wire and insulation. After winding the desired turns, the one side of the mould may be unscrewed and the coil slipped off, fastening it in several places to keep in shape, by wrapping it with black friction tape. Now tape the whole coil thoroughly, using $\frac{1}{2}$ " or $\frac{3}{4}$ " taffeta or linen tape overlapping one-half. When both coils are wound and taped, give a good coat of orange or white shellac, and dry thoroughly. Cut the heavy wire about 2 inches from the coils and solder to each, a 6 foot length of heavy lamp cord. Tape the joints after close inspection to see that they are perfectly soldered.

The instrument panel may be drilled as shown in Fig. 2 using preferably $\frac{1}{4}$ " black micarta; hard rubber, fiber or hard wood will answer as substitutes if necessary. The mounting of the terminals, switches, ammeter and buzzer is shown in Fig. 3. To construct the rheostat, drive copper or brass nails or wire into the little holes and then

laying a turn of No. 16 German Silver or Advance wire over their heads, carefully solder the wire in place at each junction. Solder the ends to the two heavy screws provided for that purpose.

The contact making buzzer is easily made from an ordinary buzzer. First solder the vibrating spring solid to the iron armature, at the same time catching a little brass strip which carries the extended contact. This spring must be solid, to give a very high frequency, as well as to make the buzzer almost noiseless. An ordinary binding post may be threaded to take a screw for the stationary contact and mounted as shown. The contacts must be made of some non-arc-ing metal such as silver, and if possible, should be of platinum or iridium. Ordinary brass, copper or iron at the point of contact will not operate perfectly.

The next point demanding the utmost care and patience in its construction is the differential current transformer. A micarta tube, about 2" long and $\frac{1}{2}$ " x $\frac{5}{8}$ " diameter, should be fastened to two end supports, either moulded composition or micarta or a wooden block to form a mould. The ends must not be made of metal. Place it on a $\frac{1}{2}$ " mandrel in a lathe or winding fixture. First solder a 12" length of thin lamp cord to .010 (No. 30) copper wire, insulate the joint thoroughly, bring out the end, anchor it temporarily and then wind a full even layer, ending about $\frac{1}{8}$ " from the side of the mould. Cover with a full turn of rice or glassine paper and wind a second layer, keeping the lathe always running in the same direction. Wrap another layer of paper, and then another layer of wire, keeping the layers of wire about $\frac{1}{8}$ " from the ends of the mould and adding layers of wire and paper until the coil is about 2" diameter. It should now contain about 6,000 turns, but this may vary within wide limits without materially affecting its sensitivity. The size of wire may vary from .015 (No. 26) to .005 (No. 36) with the

Be sure to get exactly the same number of turns in each circuit. To facilitate this, it is well to wind a temporary coil and then unwind to get the correct length. Cut off two new wires to the same length and rewind. When the primary, with its two wires wound in parallel, is in place, shellac inside with a small brush. Then make a tube of thin fuller board and slip this inside the winding. The space inside this must now be filled with soft annealed iron wire, cut into lengths about $2\frac{1}{4}$ " long. Force in as many as possible and run shellac into the ends to prevent any shifting, when complete.

The transformer may now be fastened to the face plate and the heavy leads scraped and anchored. Before further connection, the transformer must be adjusted by connecting as in Fig. 1 and moving the heavy primary wires slightly up or down, near to or away from the core, until absolutely no sound is heard in the receivers. This adjustment is important and must be done carefully and not be disturbed after it is once made. Even an $\frac{1}{8}$ " movement of a primary wire may disturb the adjustment.

The inductor balances are easily made by winding 10 turns of .064 (No. 14) insulated wire on a temporary mould and anchoring to the micarta support as shown in Fig. 5. They hold their shape from the rigidity of the wire. They are assembled in place at the ends of the transformer, so that their field may oppose, assist, or be at right angles to the axis of the transformer core. The set may now be wired as in Fig. 6, taking care to get good joints. Fig. 7 shows the completed paneled rear view.

A hard wood case may be used as in Fig. 8 to contain the batteries and plate and also to form a support for the coils. A wooden block, taped well to the coils, gives a good support for the handles. The coils must be kept the same distance apart or there will be interference.

Now select an open out-door field, free from buried water pipes or metal junk and

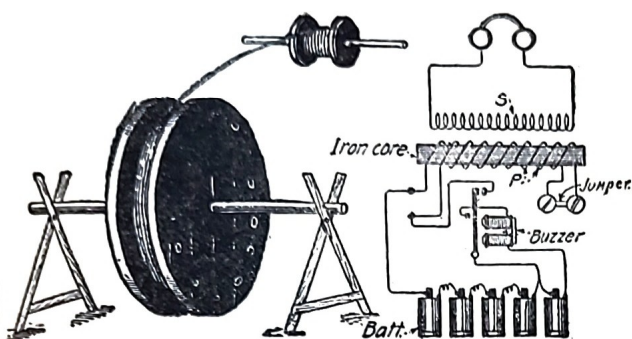


Fig. 1

Fig. 4

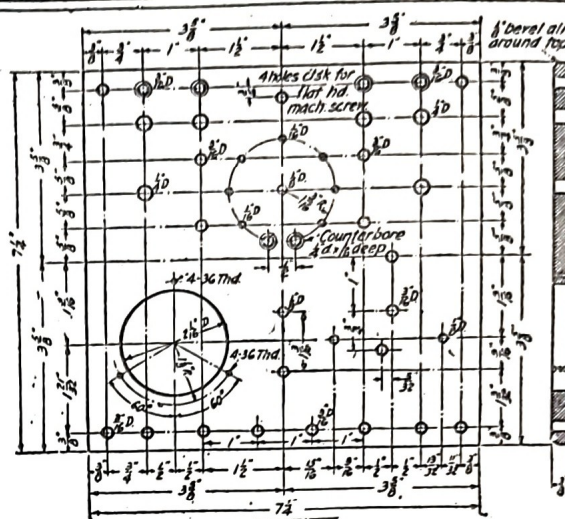


Fig. 2

Start and finish coil with lead wires and leave ends for connection not less than 3' long

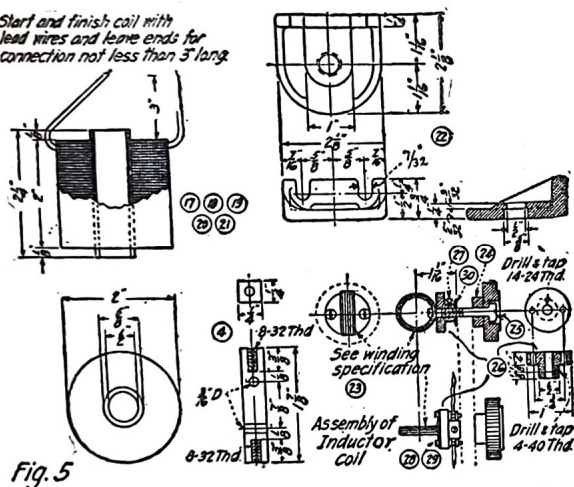


Fig. 5

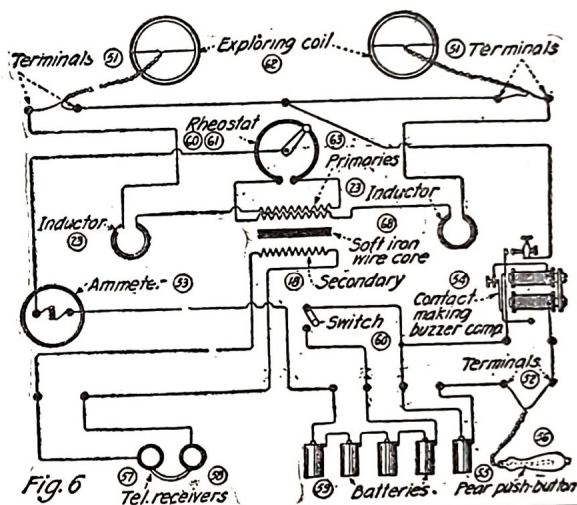


Fig. 6

The above drawing shows details to be followed in building the metallic ore and pipe locator here described by Mr. Todd. The switch panel may be made of hard rubber, black fiber, or bakelite. All of the wire leads should be carefully arranged, and made of equal length as nearly as possible, in order to help in balancing the circuits when the instrument is assembled and ready to be calibrated. The indication that the exploring coils are over buried metal, pipes or other mass is given by sound in the telephone receivers worn on the head. The presence of any metallic mass buried in the ground, anywhere from five to twenty-five feet deep, causes the inductive balance between the two exploring coils to be upset and it is this differential effect that is indicated or measured by the telephone receivers. It would also be possible to make the instrument direct-reading by using a very sensitive galvanometer, connected in place of the phones, and suitably calibrated.

setting the instrument on a temporary stand, close the main switch. Push the pear push-button to start the buzzer and slowly screw in the stationary contact until it just makes contact. The correct point is easily determined by a slight increase in the pitch of its tone and the indication of about 1 or 2 amperes on the meter. If too close, it will indicate 10 or 12 amperes and quickly exhaust the battery.

Next place an ordinary magnetic compass in the center of each coil in turn and note which end dips down. If it is the blue or North end, then connections are correct. If white or South end, the connections to that coil must be reversed at the instrument board.

Put the receivers on and push the button. The buzzer should be loudly heard. Move the rheostat handle until the sound is at its very minimum. Then turn the inductors slowly until the sound is absolutely balanced out. It may be necessary to slightly change the rheostat position, after an adjustment of inductors, but the adjustment must be obtained so close that no difference in sound can be detected with the main switch open or closed.

With the apparatus as in Fig. 8, start at one corner of the plot to be explored, and setting the coils lightly on the ground push the button. If no sound is heard, advance the coils about two feet, set them down and

again push. Repeat this until the whole plot has been explored. By thus dividing the plot up into two foot squares, it can be covered much more quickly and thoroughly than if the instrument is carried in a haphazard manner several inches from the ground.

If a sound is heard, then the coils may be shifted until the greatest sound is heard when it will be known that one coil is directly over some buried metal. It is important to note that the coils and instrument must bear a fixed relation to each other and also that the operator's head, with the receivers, must stay in the center between the two coils. If the head is bent a foot or so forward, the field from the exploring coils may cause a sound.

It must also be remembered that the change in the two circuits caused by any buried metal is so exceedingly small, that it may easily be caused by other slight changes and it is only by eliminating every other variable that correct operation can be secured.

Wood for Storage Battery Purposes

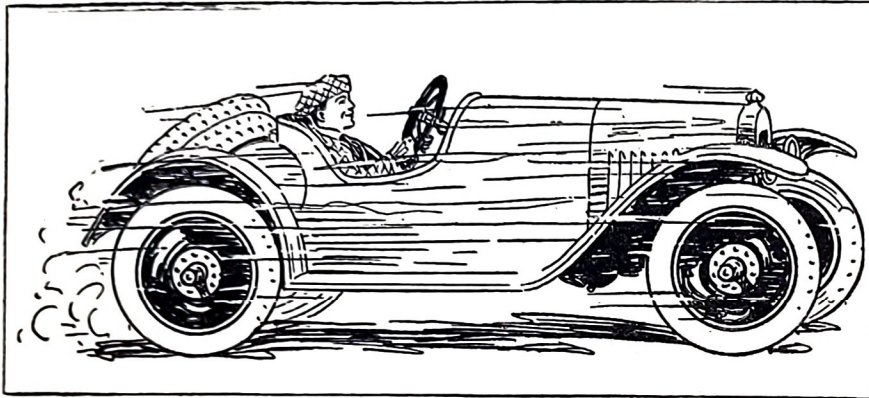
Some practical notes on the use of wood in secondary batteries and for the cases for sets of cells have been published in the *London Electrical Review*. It limits the list of woods in use in England for these purposes to pitch-

pine and teak. The author, Sir John Anderson, puts the transverse strength of a bar of teak one foot long, by one inch square as 814 pounds, while the same size bar of pitch pine only runs to about 550 pounds. The critical use of wood is for separators in the cells; the wood used for this purpose having to be chemically treated to get rid of the wood acids and it is necessary for it to be extremely porous, as it really represents a porous diaphragm. After chemical treatment, the separators are kept in water, for they must never be allowed to dry, as they would warp and split.

Standard use now favors the employment of thin sheets of wood, where formerly wooden dowels were used. In the case of grid-type negative plates, the separators may be placed against such negative plate, but must never be allowed to rest against the positive plate, as this interferes with the free diffusion of the electrolyte and causes sulfating. Wood used for containers or cases for the battery should be treated with paraffin wax melted into the pores of the wood. The wood separators, it must be remembered, have very little strength and must be handled with great care if they have to be removed from the cell. They are certainly the weak spot in the structure, and it is highly desirable that some practical substitute for them should be found.

Building a Motor Speedster

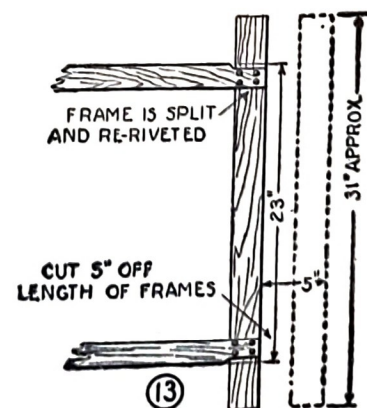
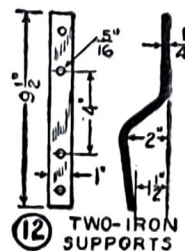
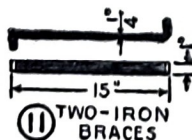
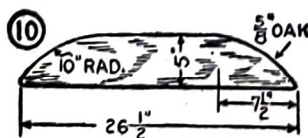
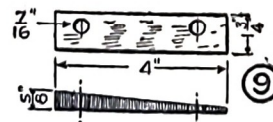
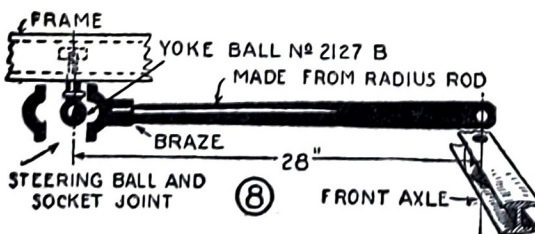
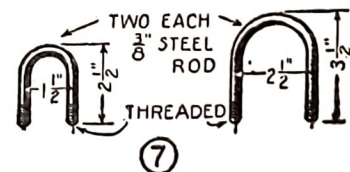
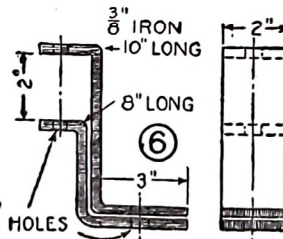
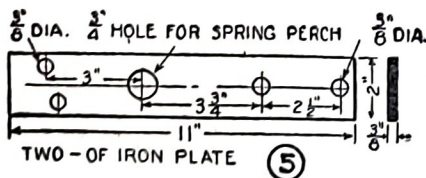
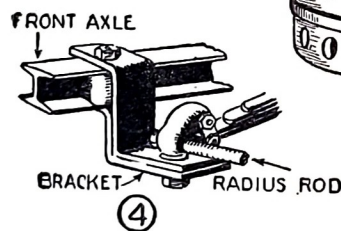
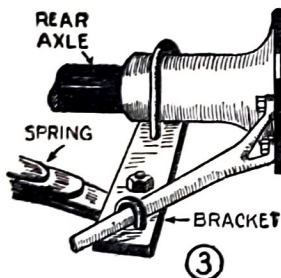
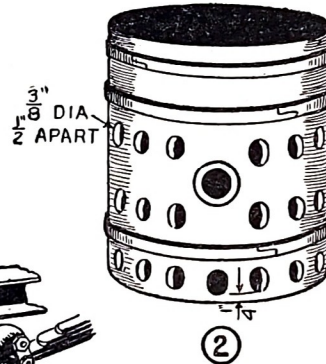
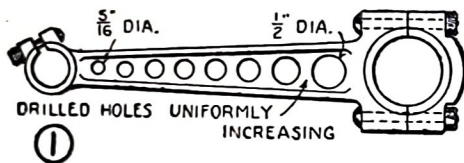
By GEORGE ARTHUR LUERS



WHO, with any sporting blood in their veins, can resist the lure of a snappy, low hung sport car? Probably every one of us has at some time or other had a burning desire to own and operate a car of this type. The cost of such an outfit, ready built, has deterred most of us from the realization of this dream. However, we are showing on this and the opposite page just how a fast auto speedster can be made from a Ford chassis and a few parts that an ordinary mechanic can make. A few inquiries in the proper direction will soon make evident the fact that a second-hand Ford chassis can be purchased very cheaply, sometimes as low as \$15.00.

The first operation is to place the engine and chassis in good mechanical condition. Clean it thoroughly and when finished, give it a coat-of black enamel in order to preserve it. Before starting work on the body, the engine must be changed. The main idea is to reduce the weight of the reciprocating parts, namely, the piston and connecting rod. This can be done as shown in Figs. 1 and 2 herewith. It is advisable also to use two gaskets under the lower crank case cover, which increases the oil supply in the troughs.

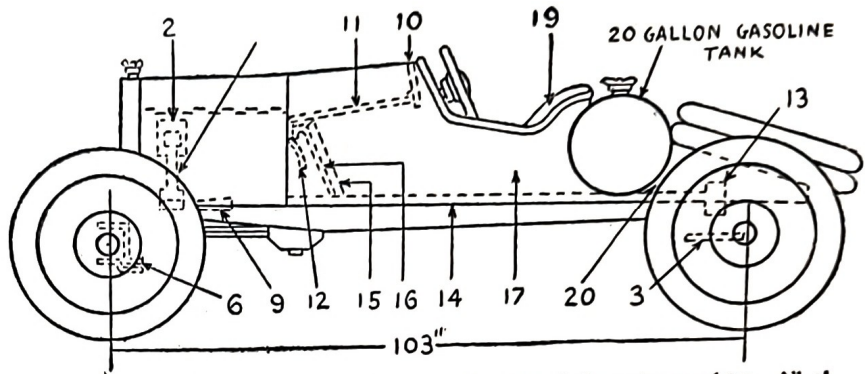
The next work is to undersling the chassis. Strap iron bent and drilled as shown is the only necessary material. The details for the front and rear axles are shown in Figs. 3 and 4, and the various parts in Figs. 5, 6 and 7. A brace which will make the front axle more rigid is shown in Fig. 8. In order to undersling the chassis, it is necessary to cut five inches off the frame, as shown in Fig. 13. The steering gear must be lowered. Use is made of a wedge, Fig. 9, and extension straps to the steering post flange, Fig. 12. An oak dashboard is to be made, Fig. 10, and placed in position with braces, Fig. 11.



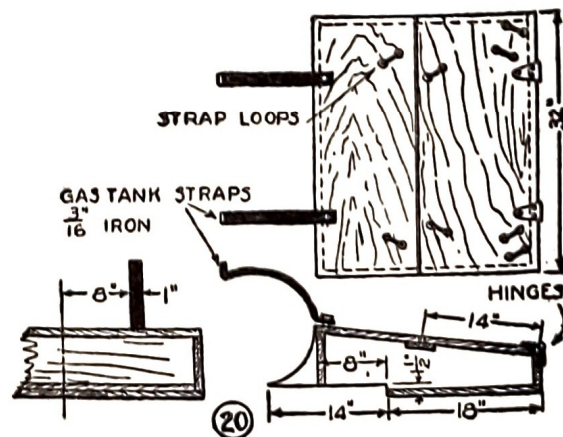
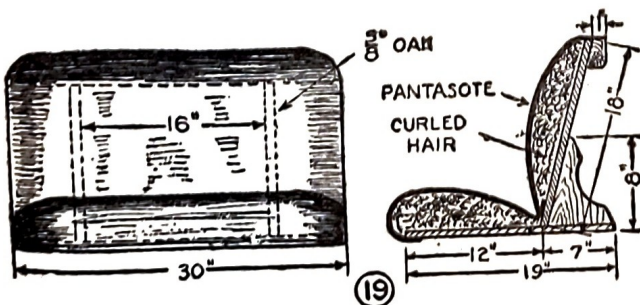
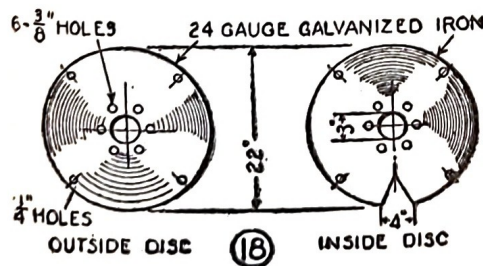
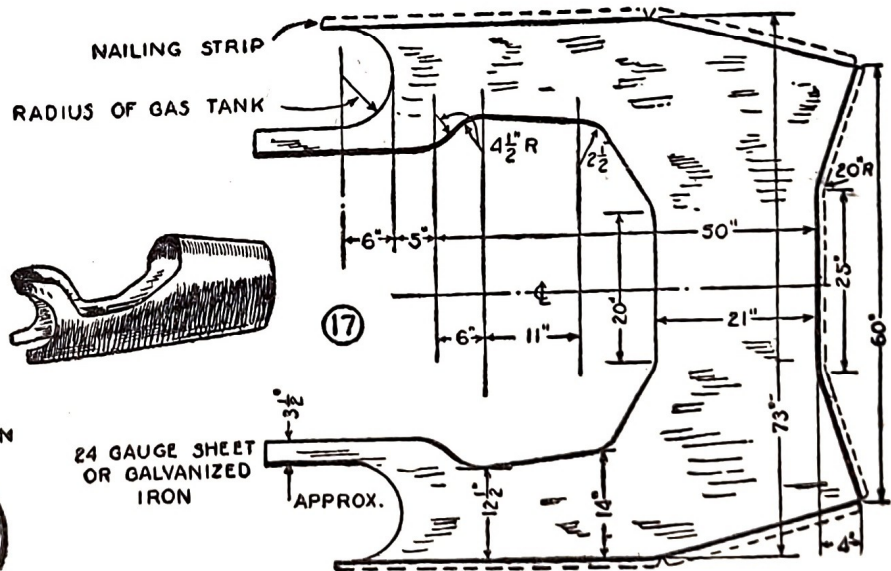
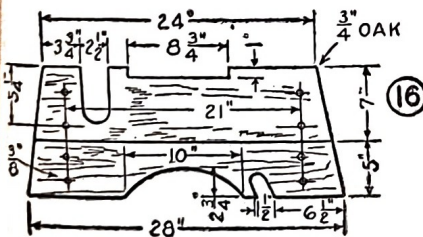
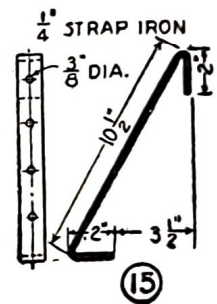
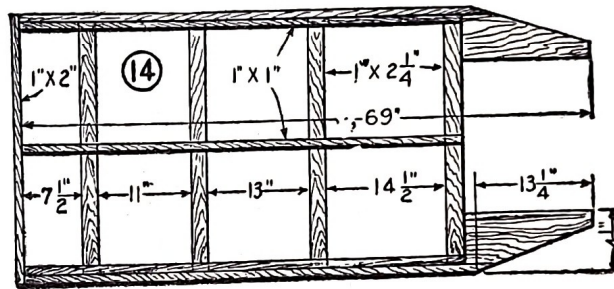
AFTER the engine and chassis changes, illustrated on the opposite page are completed, the body must next be made.

All the details are given herewith. First a frame is made up, Fig. 14, using strips for fastening together. Foot boards are shown in Fig. 16, which are to be fastened with braces made of strap iron as shown in Fig. 15. The body and the cowl are the next consideration. A pattern is given in Fig. 17, which should be reproduced in full size on a large sheet of paper. This pattern can then be placed over the metal to be used, and the latter carefully cut to the correct size. This casing is to be secured to the frame at the edges and to the dash by small large-head nails placed one inch apart. The metal may be cut in one piece as shown, or in several pieces, depending together at the junctions. For appearance, it is desirable to bead the edge of the metal by turning it over a stiff wire. The details of the seat and upholstery are given in Fig. 19 and of the tool box and gasoline tank support in Fig. 20. Fig. 18 shows how disks for the wheel can be cut from galvanized iron.

One other point that is desirable to observe in order to get the greatest speed out of this car is the muffler. It should be removed and the inside shelves taken out. This procedure will reduce the back pressure and increase the power of the engine. After the entire assembly is made, and a special twenty gallon, or the regular ten gallon tank, placed in position, the entire outfit should be carefully painted. First use a lead priming coat, sandpaper it and use one coat of color enamel. Rub this down with steel wool and apply a second coat, again rubbing this down with steel wool. One or two coats of varnish give an excellent finish. A white ivory body with black trimmings makes an excellent finish for this car.



The above illustration shows a complete assembly view of the motor speedster. All of the changes or new parts are numbered, the numbers corresponding with those given in the other illustrations. A sixteen valve engine head, sold on the market, will increase the power remarkably.



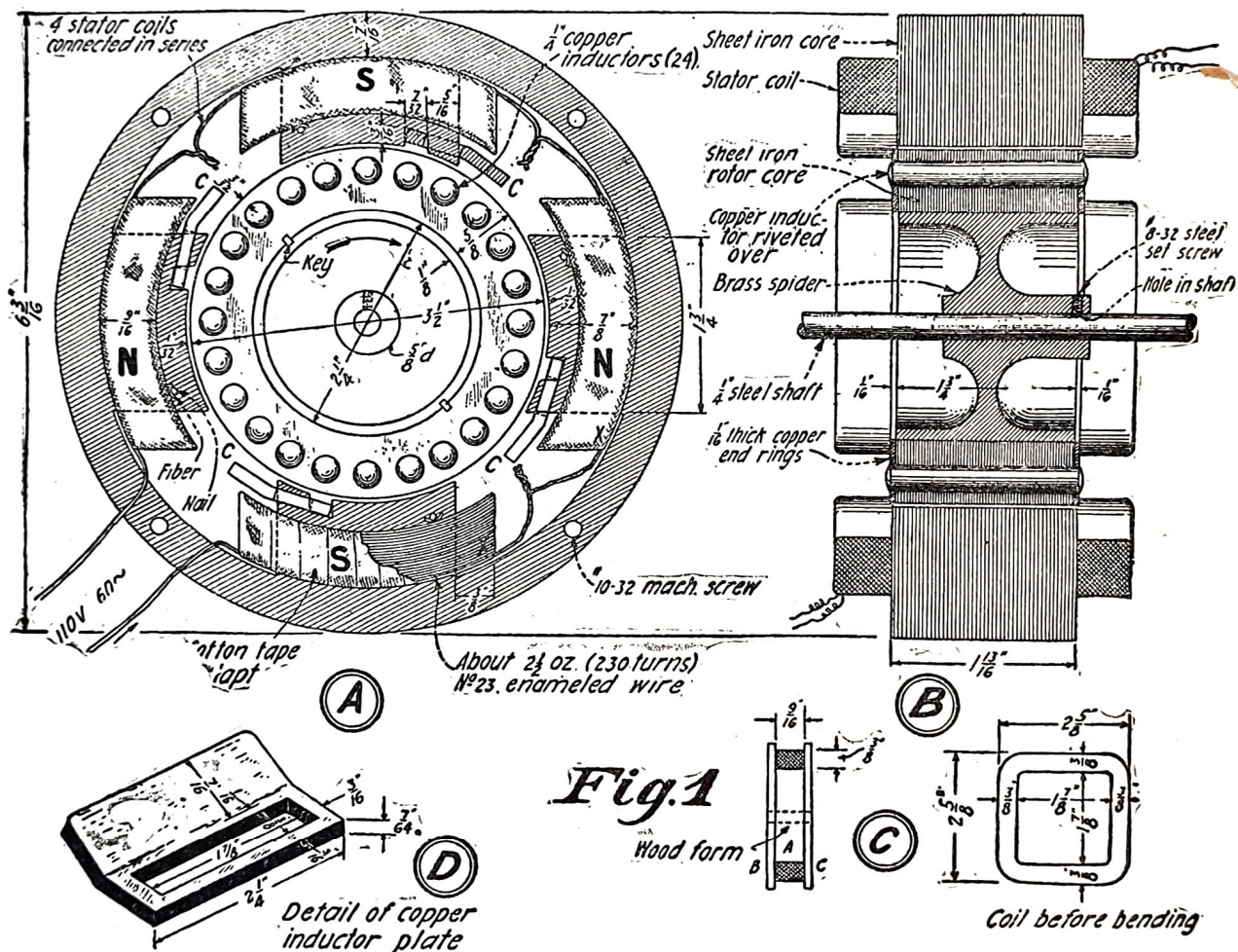
How to Build a $\frac{1}{16}$ H. P., A. C. Motor

By H. JOHNSTONE

MANY experimenters undoubtedly have a use for a small alternating current motor suitable for operation on a potential of 110 volts and a frequency of 60 cycles, but do not care to buy such a motor unless

tinner's snips. The sharp corners, such as those around the stator poles, can be cut out with a cold chisel and hammer. The 24 inductor holes in the rotor may be drilled thru the rotor iron laminations by clamping them tightly and performing the operation in a

channel in the rotor are cut thru. The rotor supporting spider should be made of brass or bronze; it could be made of iron, but this is liable to heat up more. The details of the bearings, shaft and other parts are left mostly to the individual builder, for these

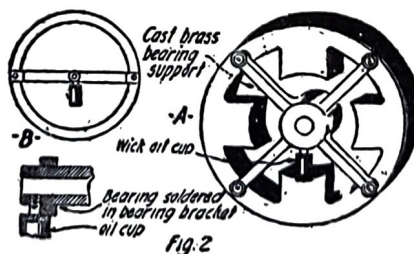


Details for building a 1-16 horse-power A. C. 110-volt motor are here given. The constructor will find this design very simple, there being but four stator coils of square shape, while the rotor is "wound" with 24 round bare copper wires passing thru slots in the iron rotor core as shown. The motor is self-starting under load and develops a reasonably high torque at starting. It makes an ideal fan motor for use with a 10- or 12-inch diameter blade. Many other uses will suggest themselves to the builder. The speed is very constant with a given load.

it is absolutely necessary. The accompanying description and illustrations show how to build a $\frac{1}{16}$ H. P. induction motor of the single-phase self-starting type. The design here given is the simplest that has ever been developed, as there are no starting coils to be wound, simply four stator coils. The squirrel-cage rotor or revolving member comprises a laminated sheet iron drum core, having 24 slots as shown, which slots are filled with 24 inductor bars, composed of heavy copper wire. The cross-sectional view at Fig. 1-B, shows how these copper bars are joined at both ends of the rotor by flat copper rings, and the ends of the inductor bars riveted over and sweated with solder.

The dimensions of the laminated sheet iron rotor and stator are given in Fig. 1. For ordinary work, black Russian sheet iron as purchased at any tinsmith's, will serve very well for the purpose, and the requisite number of sheets can be cut out with a pair of

drill press. By means of two blades placed in a hack saw frame side by side, the thin slots over the top of each round inductor



Detail suggesting how bearings may be constructed, but this is a matter of choice. It is best to have a machinist accurately align the two bearings and drill the holes in the brackets.

will often be governed by circumstances. Thus $\frac{1}{8}$ " diameter shafting may be available instead of $\frac{1}{4}$ " shafting, etc.

Let us now consider the stator and its four coils as well as the copper starting or shading plates, at C. The four stator coils are composed of 230 turns of No. 23 B & S gauge enameled magnet wire, but if this is not available, single silk covered magnet wire may be used. This will require somewhat over two ounces of wire per coil, and $\frac{3}{4}$ of a pound of wire should suffice for the whole job. A simple wooden form, such as shown at Fig. 1-C, is constructed for winding the stator coils. The coils measure about $\frac{1}{8}$ " in width by $\frac{3}{8}$ " in depth. The other dimensions are given in the drawing. Flexible lead wires should be soldered to the magnet wire and tied in position with a string, before the coils are taped. Ordinary cotton tape about $\frac{5}{8}$ " wide is used and lapped about one-half its width. The coils are taped before bend-

ing, the amount of curvature being very slight. A piece of oiled linen or Empire cloth should be cut to fit around the iron stator pole before the coil is placed in position, and this should be cut large enough so as to insulate between the yoke and the coil as at X, Fig. 1-A, to prevent grounds and short-circuits between the iron frame and the windings. The oiled linen insulation around the pole should be arranged to cover and extend over the top of the coil also, under the copper starting plate, so that this will not bear directly upon the tape covering the coil. The dimensions of the four-copper shading plates are given at Fig. 1-D. These plates may be a little thinner or thicker than the dimensions given, without reducing the efficiency of the motor to any noticeable extent. The direction of the rotor when revolving, is shown by the arrow; it is right-handed or clockwise with the four shading plates in the position on the stator poles here illustrated. To reverse the direction of rotation of the rotor in this type of A. C.

motor, it is necessary to reverse the position of the copper shading plates. That is, the four plates will have to be placed on the opposite corners of the four stator poles.

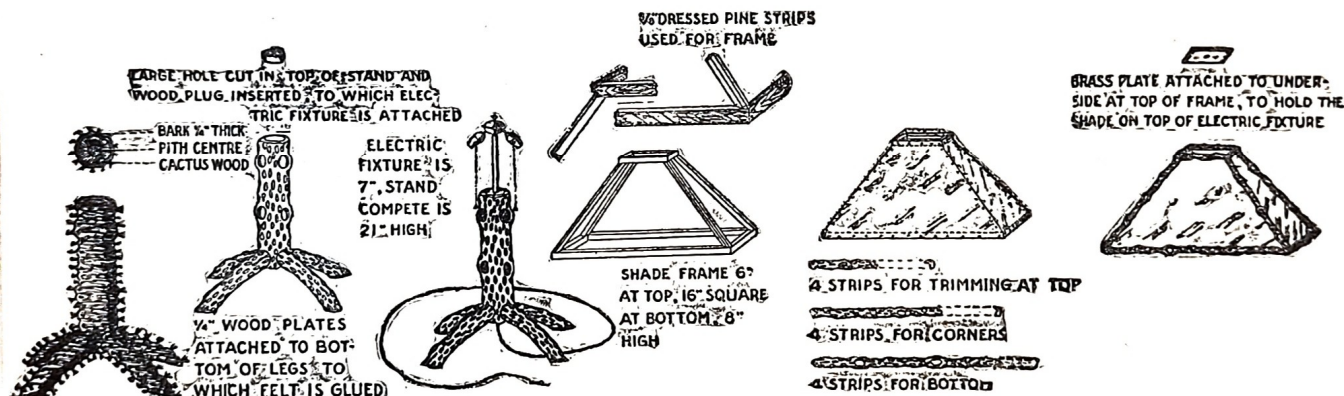
The four stator coils are connected in series, and the direction of current thru them is checked, if necessary, by connecting to a source of direct current, either thru a 100-watt lamp on 110 volts D. C., or else to a source of battery current having a potential of 10 to 12 volts, and the polarity checked by means of a small pocket compass held near each pole so that they alternate as shown—south, north, south, north. Each successive pole should attract opposite ends of the compass needle. If this form of test is not used, then by remembering which way the coils and leads are arranged, the direction of the current passing around the successive poles can readily be traced, and the current should reverse its direction around each successive pole.

The bearing supports may be designed in several different ways and by studying the

construction and form of some of the small commercial motors upon the market, some practical ideas in this direction will easily be gleaned. In any event the bearings should certainly be fitted with wick oil cups, which can be purchased from any electrical repair shop selling fan motor supplies, etc.

This motor will be found useful for driving fans, either 10" or 12" diameter of blades, or for driving rotary spark gaps in radio sets, and other light machinery. When the current is switched on to the stator coil terminals, the motor is self-starting and it soon reaches its speed of 1750 revolutions per minute. The synchronous speed of this motor is 1800 R. P. M., but there is always some slip; so if we allow 3% for this factor, then the net speed with load, figures out to 1,746 or practically 1,750 R. P. M. The speed of an induction motor in R. P. M. is found by multiplying 2 times the frequency in cycles per second by 60, and dividing this product by the number of stator poles.

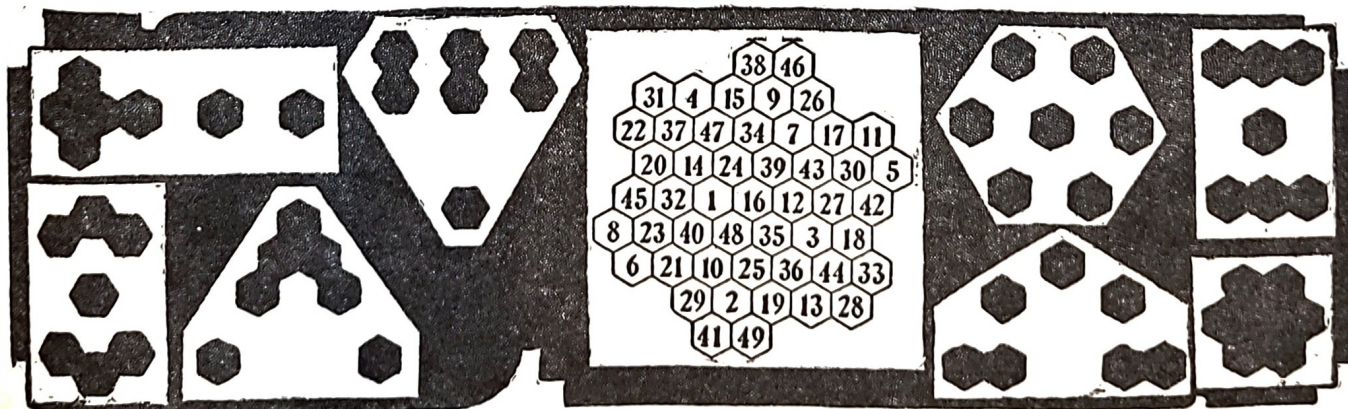
Making Cactus Lamps



The above photographs and drawings show how the Cholla cactus can be made into a very beautiful and novel lamp. In the upper left-hand corner is a photo of the finished lamp, made by the author. Parchment paper stretched across the corners of the shade frame and then painted with natural scenery, some of which is shown in the upper right-hand photograph, makes a very effective and attractive lamp. First, a piece of cactus is cut off as illustrated in the top center diagram. The bark is then entirely removed but care must

be exercised, so that the spines do not get into the skin. When the bark comes off, the wood appears to be very knotty. After all of the pith has been removed the wood is full of holes. The top of the frame is now hollowed out and plugged for the electric light fixture. The stand is stained and rubbed down. Meanwhile a frame is constructed as indicated in the diagram, and covered with parchment and painted. The edges of this frame are fitted with cactus trimmings and the whole makes a picturesque lamp.—Byron W. Sieg.

Marvelous Number Squares

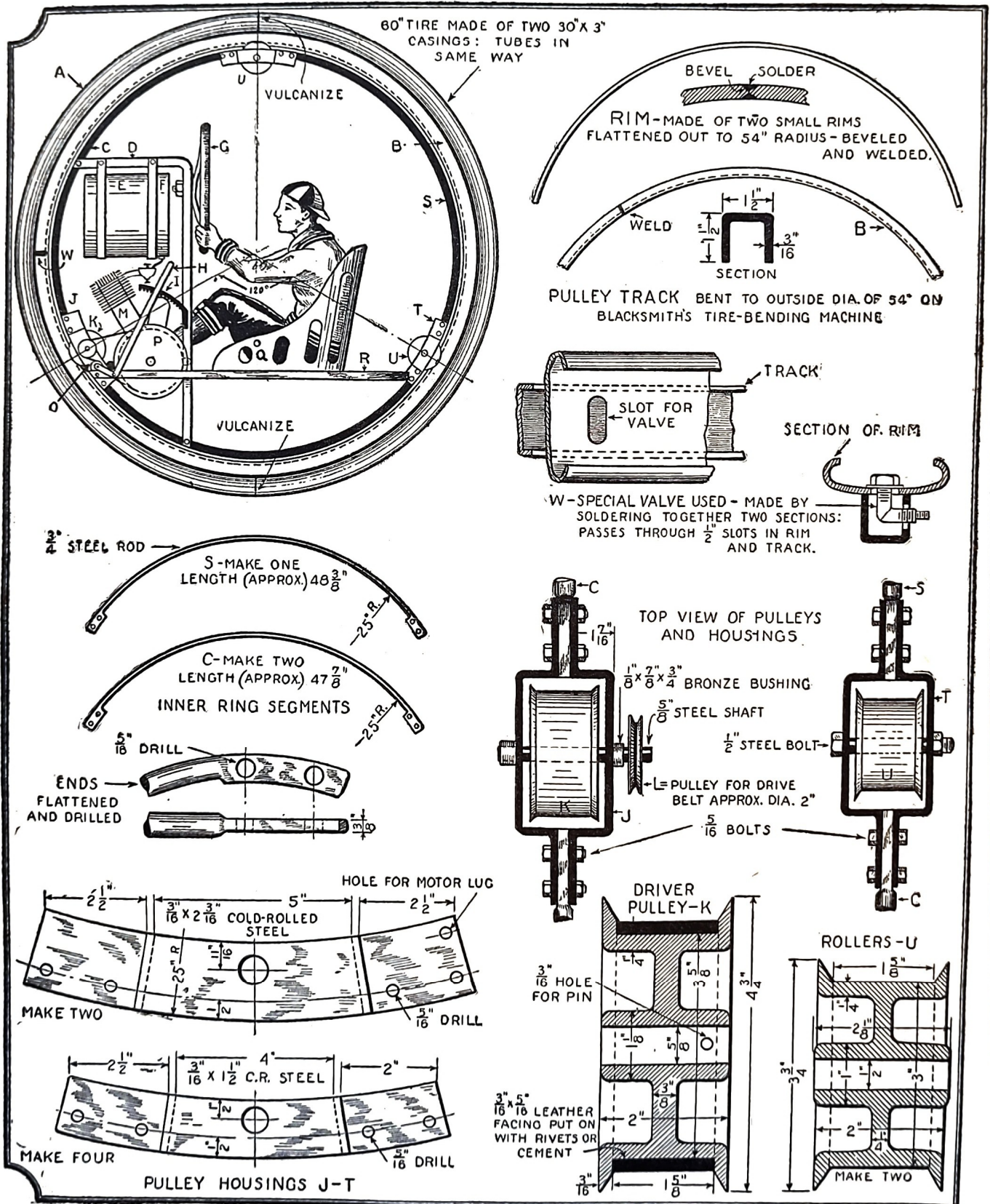


If the numbers from 1 to 49 are placed in a nest of hexagons in the style shown above each group of seven hexagons will give one sum when added—175—and each column of seven hexagons will give the same sum. Also, there are more than 200 other combina-

tions of non-adjacent hexagons which give the identical total also. Some such combinations are given above. Cut bits of paper so the numbers show through and find some of the 200 combinations. The second row of figures = 31415926 or pi.—A. Gruntal.

Building the Motor Hoop

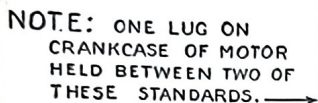
By JOHN GALEN BARBER



The motor hoop is an interesting idea as well as a practical vehicle. It will give efficient, economical service and is capable of travelling at a speed of approximately 35 miles an hour or more. The device has been so designed that those parts generally found in a small service station or

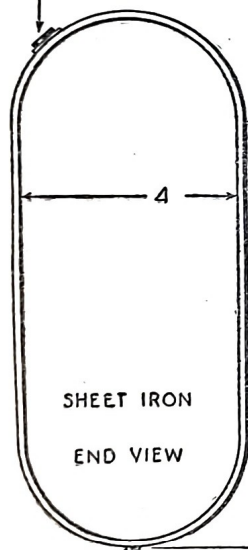
garage could be used for the construction of this vehicle and the mechanical ability for building it is usually available locally. There is no doubt but that it would attract considerable attention. It will ride smoothly and can negotiate bad roads with ease.

MAKE TWO



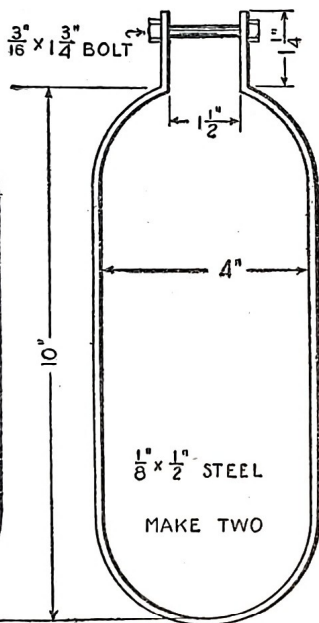
NOTE:

GAS AND SPARK CONTROLS
ATTACHED CONVENIENTLY TO
STEERING WHEEL



SHEET IRON

END VIEW

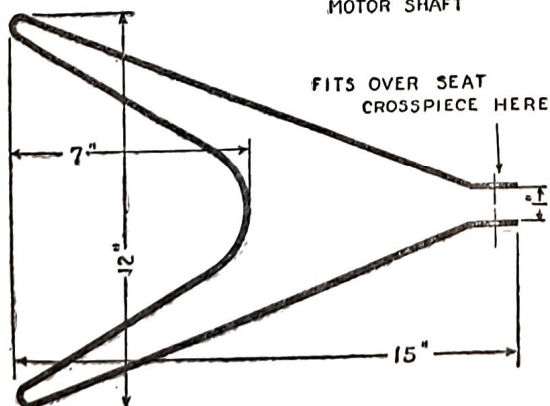


MAKE TWO

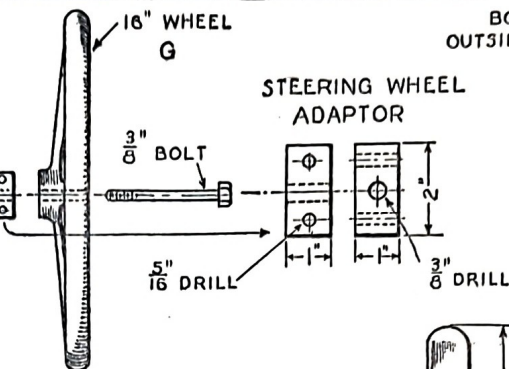
CLAMP - F

GASOLINE TANK-E

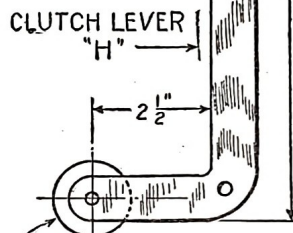
NOTE: CHAIN DRIVE MAY BE SUBSTITUTED,
WITH OR WITHOUT CLUTCH ON
MOTOR SHAFT



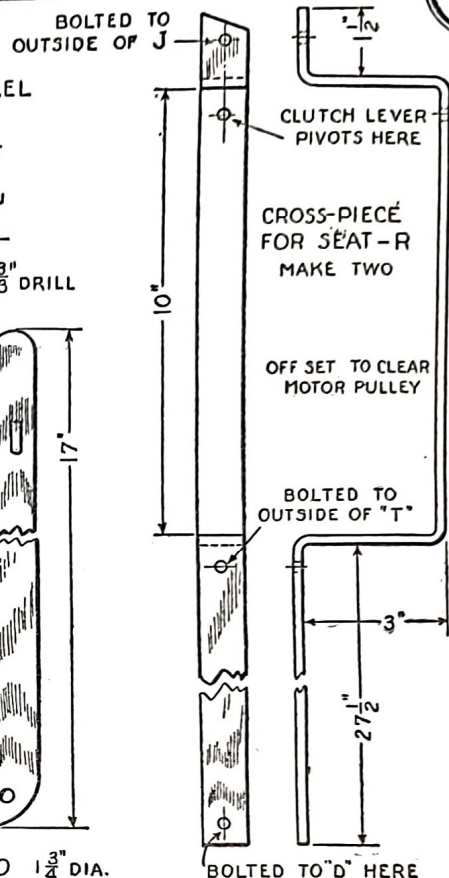
STAND - SWINGS UP UNDER SEAT
WHEN NOT IN USE'



STEERING WHEEL ADAPTOR



IDLER PULLEY - O 1 $\frac{3}{4}$ " DIA.



CROSS-PIECE
FOR SEAT-R
MAKE TWO

OFF SET TO CLEAR
MOTOR PULLEY

BOLTED TO
OUTSIDE OF "T"

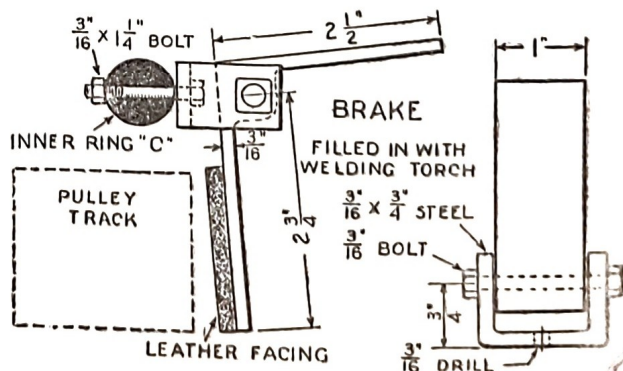
BOLTED TO "D" HERE

ALL the parts of the motor hoop are lettered, and the detailed drawings for each part are given and their association can easily be found by reason of the corresponding letters. The rim of the motor hoop is made of two standard rims, cut and welded together. The channelled iron track is bent on a blacksmith's tire-bending machine, and the brake parts are welded together. The tire with which this device is equipped is made by vulcanizing two standard 30 by 3 inch tires. The inner ring to which the motor and accessories are attached is bent from round bar steel. These sizes of course may vary if the individual attempting to use the motor wheel is of unusual physical proportions. The outer tire and rim revolve about the inner ring on three rollers, one of which is driven by the motor. Power from the latter is transmitted from the 9-inch pulley on its shaft, to a 2-inch pulley, thence to the shaft drive roller, and finally to the big outer tire. A chain drive may be used if desired, but in this construction a belt was used and a clutch added as illustrated. Spark and gas controls are attached to the steering wheel, which is a dummy and serves merely as a convenient grip. Steering is accomplished by shifting the balance of the machine causing it to lean in the direction in which it is desired to turn, as in the case of the child's toy hoop. Ordinary braking is done by reaction against the motor compression. The foot brake is used for emergency or quick stops. The operator prevents the machine from falling by extending his foot on either side, and when the machine is not to be used for a while, the operator lets down the stand, normally folded under the seat, where it is held by a spring clip.



FINGER WHICH
ENGAGES
NOTCHED SEGMENT

NOTE SEAT IS AIRPLANE, AUTO-
BUCKET, OR MOTORCYCLE
NT SEAT



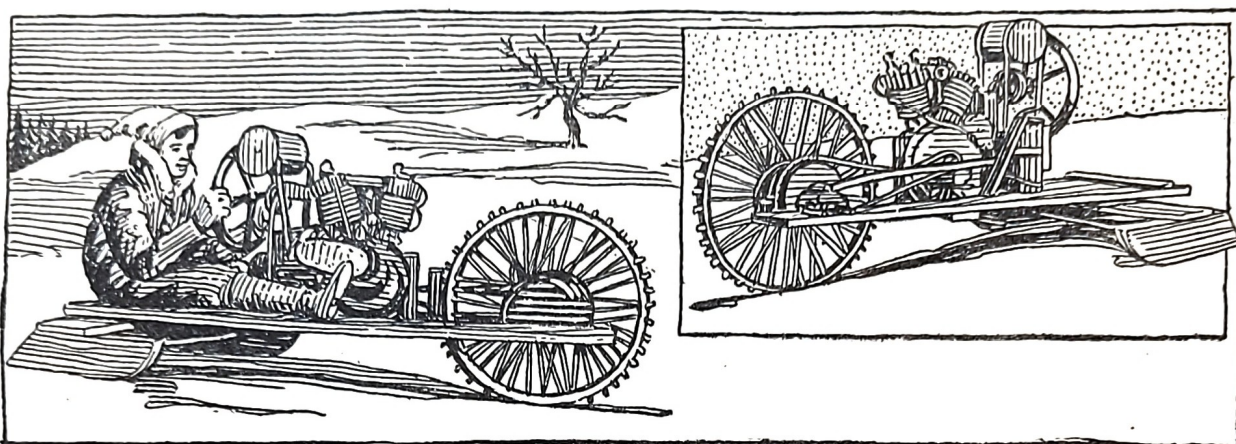
BRAKE

FILLED IN WITH
WELDING TORCH

PULLEY TRACK

LEATHER FACING

Ice Boats and Speeders



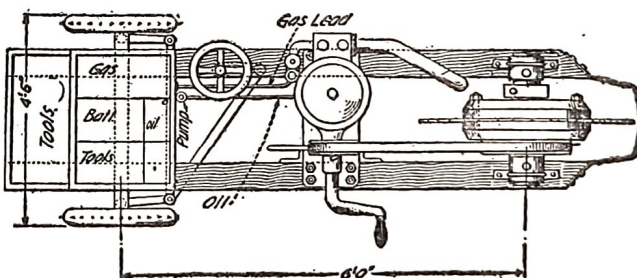
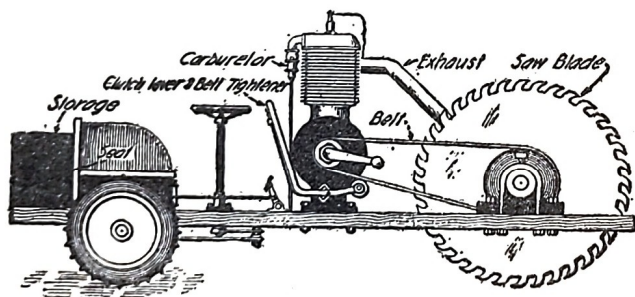
There is probably no greater sport for the winter months than ice "boating." In the accompanying drawings and text general directions are given for the building of both small and large ice boats. A small ice speeder with gasoline engine drive is shown in the drawings below, as well as in the photos above. An old circular saw blade makes a very good traction drive wheel for the ice speeder, and where this is not available a substantial wooden wheel may be used, providing the periphery is fitted with a series of iron spikes.

NOW that the winter is upon us, the question of what sports are to engage us during the dreary bleak winter days is foremost in our minds. Of course there is sleighing, skating, skiing, and tobogganing, but the finest sport of all without a doubt is *ice boating and speeding*. With the instructions given here, ice boats or speeders can easily be constructed. Bill Caley has contributed two photos of his ice speeder which show clearly the mechanical lines upon which one type of speeder was built by him-

clutch upon the engine was so arranged that it may be thrown in or out as desired. The brake to the wheel is of course placed so as to be easily accessible. Runners are mounted in the rear and pivotally arranged, steering being accomplished thru their aid. Under very adverse conditions, in which the ice was covered with two to four inches of snow, this sled actually made 60 miles an hour.

Mr. P. P. Avery gives the following details for constructing an ice speeder and also an ice boat. He says that the following two devices can be easily constructed and will

inch rawhide belt which has been fully stretched. This will be used to drive the power wheel. A bent lever with a ball-bearing idler wheel releases the slack of this belt when it is desired to maneuver slowly, and when the idler wheel is so adjusted that all the slack of the belt is taken up and consequently no slippage is obtained, practically the full power of the motor is delivered to the power wheel. Altho the carburetor and the oiler of the motor-cycle are not changed, the gasoline tank and the oil tank are both equipped so that air pressure may be applied if desired. The same magneto



self and his partner. He had an old 1915 motor-cycle and removed its engine and placed it in the speeder, and many of its other parts were used to great advantage. The rear wheel of the motor-cycle was mounted so that it could be used as the drive wheel of the sled and was placed up in front. To this wheel the engine was directly connected by means of a chain and never-slip horse-shoe calks were riveted to an iron

be valuable to anyone located near a body of water which freezes over in the winter time.

First, make a frame of 3"x4" wood strongly bolted together. A good 6 or 7 horse-power air cooled motor-cycle motor is clamped to this frame. Then procure a 1½

is used for ignition which is usually found on these motor-cycle engines, but because of the extremely cold weather at times, it is desirable to insert a separate battery system for easy starting. The driving wheel consists of a 36-inch circular saw blade which may be obtained from any second-hand machinery dealer. Holes are drilled thru this to hold the axle, wood hub and bearings in place. The gasoline and oil tanks, as well

The two diagrams above show a side and top view of an attractive little ice speeder. It is driven by a motorcycle engine and it will travel over the ice at a great rate of speed, up to 60 miles an hour and better.

rim, which was subsequently placed over the wheel. This furnished the necessary traction. The engine was then mounted upon the frame, which is but 7 ft. long, and the

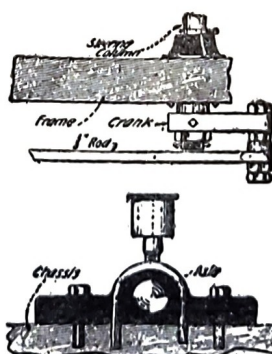
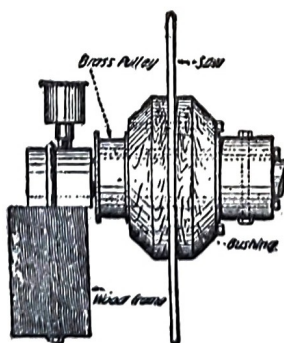
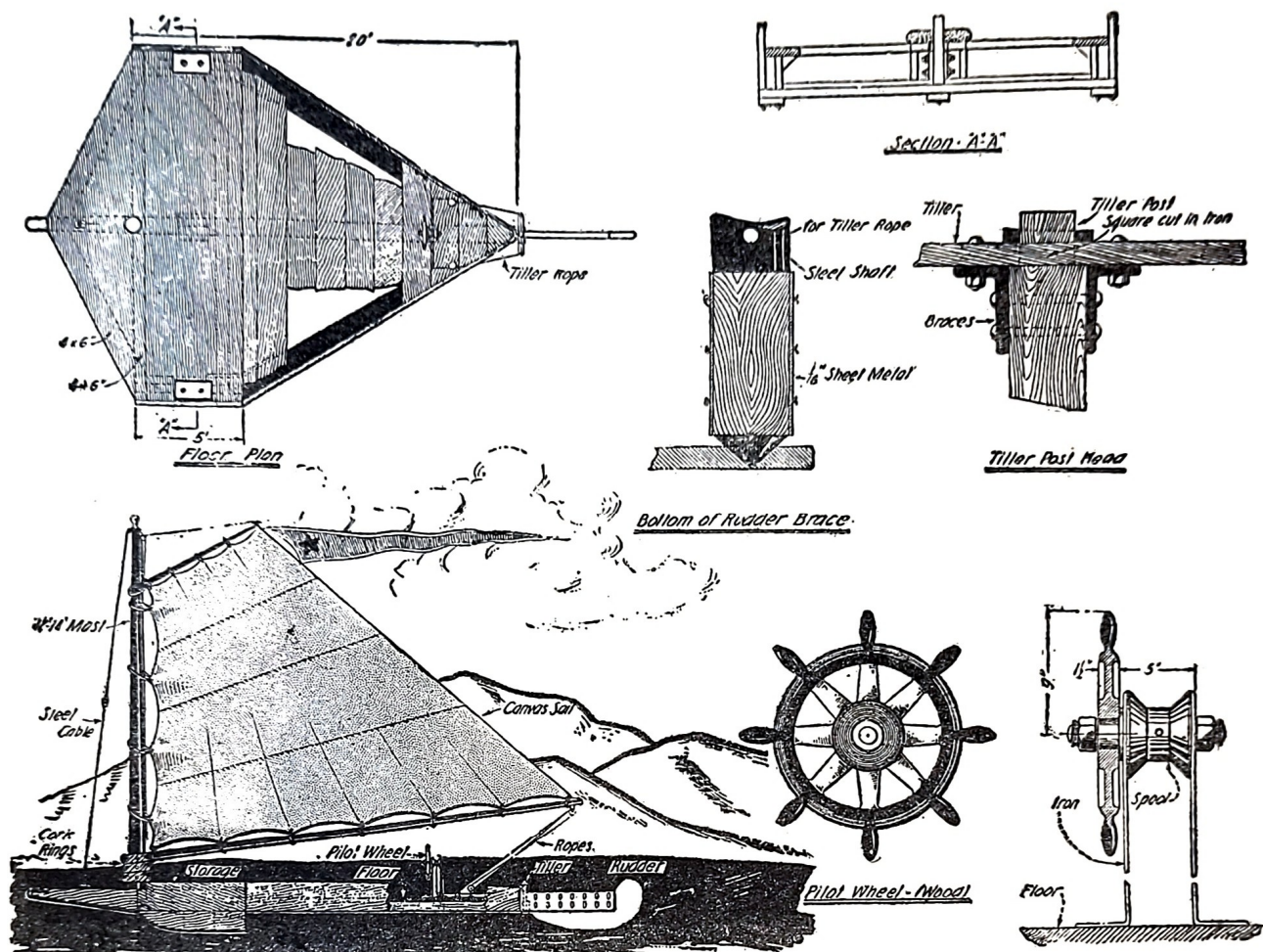


Diagram at the left includes details of Mr. P. P. Avery's Ice Speeder, provided with a circular saw as the power wheel which propels the craft over the ice. The cost of building such an ice speeder is insignificant compared to the pleasure one may derive.

as the battery and coil, can be placed under the seat, and wires leading to the spark plugs should be run thru metal conduits. A word in regard to the steering; this is simply



Probably the greatest sport in all ice boating is to be found in the handling of the swiftly moving sail-propelled craft here shown, as reproduced from the drawings of Mr. P. P. Avery, M.E. It has been said that aside from the airplane, the swiftest moving craft in the world is undoubtedly the ice boat, which has established a speed record of over two miles a minute. The mast of the ice boat should be well stayed in position from either side, as well as at the front, using turnbuckles to pull the cables or ropes taut. Those desiring a smaller craft than the one shown, will gain some good ideas from this article as to the steering arrangement, and they will be surprised at the speed obtainable even with a small sail when there is a good wind blowing. One feature of the ice boat is that there is no gasoline to buy.

accomplished by means of a 1 inch rod and plate connected to an arm which connects with the regular type of front axle cut to fit. A 14 inch steering wheel is preferably employed, to which are attached the necessary controls for spark and gas. The brakes are drums of wood fastened to the wheel spokes and fitted with the usual brake lining. The brake action is fitted under the floor with a pedal protruding and connected to the brake proper by means of a flexible steel cable. The entire floor is then covered with 4"x1" yellow pine, and over this, along the edges, molding is rigidly fastened to give it a neat and finished appearance. By following the diagram closely and by using a little ingenuity, the reader can develop a very successful machine capable of driving him across the ice lickety-cut at a speed of from 45 to 70 miles an hour. In starting the motor, it is most desirable to retard the spark control and just give the motor a little gas. The clutch is thrown out so that the belt is quite loose; the brakes are applied and a small stone is placed under the driving wheel for safety. A crank is then slipped over the motor shaft and after a few smart twists, the engine will start off. The crank is now removed and the spark advanced, but the gas is kept low and the engine is allowed to run until it idles nicely. The stone may now be kicked away and the clutch lever slowly pulled in until the entire contrivance starts to move. The gas is thrown in fuller when needed.

The ice boat is a little easier to construct. First procure a board of spruce and cut this as illustrated and bolt the pieces together. Then make two side runners and fasten them together, first bracing them with 3/16" sheet iron. Now purchase a mast and step this in place with the necessary fittings running a 1/4" steel cable from the top of the mast down to a screw eye in the bows, with a turnbuckle conveniently located in the middle of this cable to allow for taking up of any slack. The rudder is firmly set in collars, and a tiller made of a piece of 3/8"x2" wood is secured to the rudder. Cords are run thru pulleys all along the sides of the craft up to the steering wheel shaft, so that it is not necessary to use the wheel when steering the craft. This cord enables the rider to steer it regardless of his position upon the craft. The frame is now strongly criss-crossed with pine and cross wires with their necessary turnbuckles may be inserted to make the entire boat more rigid. The floor is then covered with 1 inch yellow pine. Great care must be exercised in the setting of the sail and a good quality of duck is a very serviceable cloth to make the sail from. Any type of halyard or any number of pulleys may be employed for hoisting the sail in position, dependent entirely on its size. The shape of this boat makes it possible for riders to quickly shift their position and great speed may be attained.

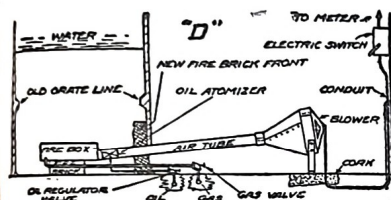
In the smaller crafts a tiller is preferred instead of a wheel. Under the

circumstances the tiller would have to be arranged so that it will line up with the rudder. The addition of a tiller makes it easier to maneuver the craft. Of course the mast should be suitably guyed by stays; three are quite enough and each should be equipped with a turnbuckle so that the stays and shrouds may be tightened at will.

The rings holding the sail in place should be numerous, more than are shown in our illustration of course, and the sail must in all events be very carefully fitted, otherwise it will bag and much of the energy imparted to it by the wind will be lost. The closer the sail comes to being a flat board surface, the better the sailing qualities of the craft will be. Whenever it is found that the sail is rather difficult to stretch to its fullest extent, several pulleys may be inserted at either end so as to allow the rope to pass back and forth four or five times. This permits of sufficient traction upon the rope to hoist the sail to its fullest extent without appreciable effort on the part of the pilot. No brake is required in this boat, in that in order to stop the vessel its nose is turned into the wind or else the sails can be suddenly released. Speeds as high as a mile a minute are rather common with this type of craft and much better records have been attained in races.

The piping, preferably of galvanized iron, is clearly shown in the sketch "A." The filler pipe, of 2" size, is connected to the tank from the curb box. This box is placed in some convenient location easily accessible for the oil supply truck.

If the filler pipe is run off to some distance it is better to insert a tee in the upright pipe, the top opening in the tee being used for the insertion of a measuring stick which may be calibrated to determine the amount of oil in the tank. This pipe, using the tee, is shown in drawing "J." The filler end should be provided with a cap. The vent line may be of pipe not smaller than 1", and the riser should extend 6 to 10 feet above ground, ending in a return bend.



Arrangement of oil burner in fire box of boiler, also layout of blower, oil and gas valves, etc.

The suction line is of one inch pipe and should extend to the bottom of the main tank, the end being equipped with a foot valve which prevents the return of oil. A running thread with lock nuts and a coupling provide means for connecting the suction line to the tank. This line is connected to either a hand or motor driven pump by means of valves and unions. A pump is placed above the pump as shown, so that the pump may be primed. The foot valve will eliminate subsequent priming. All joints on the oil pipes are made with a thick mixture of litharge and glycerine, care being taken to carefully remove all cutting oil and dirt from the pipe and the threaded ends before applying. Mix the sealing compound only as needed, for it hardens rapidly, and once hard is useless and must be discarded. The joints on the gas pipes may be made up with red or white lead.

The small tank into which the pump discharges may be of about fifty gallons capacity and should be set upon a pipe stand or concrete base. It should be provided with the openings shown, and if a concrete gauge is desired an additional open-

ing is necessary. The overflow pipe also acts as a vent. The tank should be given a coat of rust-resisting paint and is to be provided with a drain at the bottom, in the event of there being water in the oil.

The feed line to the burner should be of 3/8" pipe, and may be concealed by running in a channel in the basement floor. A shut off valve and strainer are to be installed near the tank as shown in drawing "A." Drawing "B" shows the hook-up if only a house tank is decided upon, the disagreeable feature of this installation being the necessity of constant refilling, unless the tank be of large size.

For the usual medium sized house heating plant, whether it be hot water, steam or air system, a nine inch "fire pot," or combustion chamber is used, although when this chamber is first installed in the ash pit the builder will feel skeptical because of the great contrast in its size to that of the original coal grate. It is best made of boiler steel 3/8" or more in thickness with a lap joint and bottom plate welded on. A hole is drilled in the bottom plate for a gas pilot light while the side has either an opening drilled for the air tube or has a suitable flange welded on. The air pipe may be threaded and lock nuts used to hold the pipe and fire-chamber together, or the pipe may be screwed directly into the flange, if one is provided. The pilot gas light consists of a lava tipped bush set into the bottom of the chamber, so that only the tip protrudes. This pilot flame must be protected from the draft of the blower by a shield made of molded fire clay, shaped somewhat like a section of an Edam cheese, but hollow at its greatest thickness, as shown in "G." The top of the shield should be about an inch above the burner tip.

The blower consists of a sheet iron funnel housing an eight inch ventilating fan, the construction of which is shown in drawing "I." This housing is provided with two openings through which the air is drawn. An adjustable shield is shaped as shown in drawing "H" and mounted upon the body of the blower, and is used to determine the proper amount of air, when it is locked into position by means of the wing nut. Two legs should be riveted to the body for support while the two and one half inch steel tube, usually about three and one half feet in length, is bolted into the funnel sleeve with two quarter inch stove bolts.

A Venturi constriction is turned from either brass or iron and made to fit the tube snugly as shown in drawing "F,"

which gives the dimensions. Another smaller constriction is made of brass and is used as an oil atomizer. It is shaped as shown in "E," which gives the dimensions, the centre being drilled with a 3/4-inch drill. The central cylindrical part is 5-32 inch long. A 1/8 inch drill is run through to give an oil duct and the lower part is further drilled and tapped for a 1/8" pipe. The oil atomizer is mounted upon washers and fastened in place by a 1/8" pipe nipple, which is held by a coupling or lock washer from the under side. The oil pipe is joined to the atomizer by means of a reducing ell 3/8 inch x 1/2 inch, as shown in drawing "F 1."

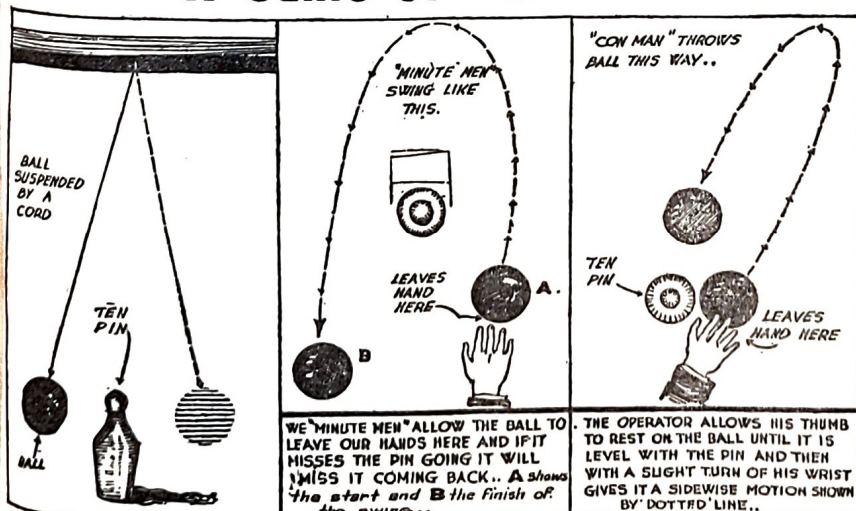
When all material has been checked over the apparatus is assembled as shown in "D," and after removing, the coal grate is installed upon the ash-pit floor, being raised from it by two fire bricks one on either side of the gas line. The open front space, however, is walled up with fire brick, using ground asbestos as a cement. Merely mix the asbestos with water to provide a thick clay-like mass and apply to the wetted bricks, taking care to tamp each brick into place. The legs of the blower should rest upon a two inch slab of cork lagging set into the floor. While not an absolute necessity it greatly reduces vibration and noise. The gas line should be provided with a stop cock, the oil line with a stop valve, regulator valve and strainer, while the electric line should be provided with a switch and fuse box.

Before running a test make sure that the chimney and boiler flues are clean, then open the gas cock and light the flame pilot, start the fan blowing and open the oil shut-off valve at the tank, while the oil regulator valve should be just lifted off its seat. The shield on the air openings is then adjusted so that the resulting flame in the combustion chamber is an intense white fire of great heat. Too much air and oil, or too little, constituting an unbalanced mixture of oil and air cause the fire to smoke and the builder should experiment until he has regulated the air openings and the oil valve, so that the flame is without a trace of smoke, for with perfect combustion there is no waste.

It is best to allow the gas in the pilot flame to burn in the event of there being water in the oil which may momentarily cause flame to cease, although the combustion chamber is generally hot enough to ignite the atomized oil even after a stoppage of several minutes duration.

—L. K. WRIGHT.

A Game of "Skill"?



The next time you go to a fair and try your luck at the ten pin game, carefully observe the way the operator handles the ball. You will notice that the ball leaves the hand directly alongside the ten pin. If you duplicate his system exactly, the ball will hit the pin every time. The secret is shown above.

Protecting Floors



It is occasionally necessary to move a heavy trunk from one part of the house to another over polished floors. This can be done with great ease and without damaging the floor by inverting an ordinary fibre (jute) door mat, and slipping it under the trunk.

—S. I. Phillips.

An Electric Railway for the Kiddies

By H. WINFIELD SECOR

IT does not necessarily entail a great deal of expense or time to build an electric railway for the kiddies, but simply a little ingenuity and the well chosen application of odd material frequently to be found lying about the place. The miniature locomotive and tender car or the small trolley car here illustrated can be driven by a 110-volt D. C. or A. C. electric motor, or a $\frac{1}{4}$ to $\frac{1}{2}$ horsepower gasoline engine may be substituted. Chain or belt drive may be employed between the motor and the axle of the car, and where chain drive is used it will generally be found preferable to arrange a speed reduction gear with jack shaft as shown in one of the detailed illustrations.

The rails may be placed about eighteen inches apart, and several suggestions for building them are clearly shown in the accompanying figures, the form of rail used depending upon the materials available, and also upon the cost of the material, where it has to be purchased new. The builder may be fortunate enough to pick up some flanged iron wheels of small size, or otherwise they can be built of wood with a flanged piece nailed on to one side. The wheels used on a trolley car of this type built by the writer when a boy were turned up on a lathe from one piece of thick plank. Very good axles for the main wheels may be formed of one-inch pipe, the two wheels on the chain driven axle having to be pinned or held tightly in place by flanges and lock nuts, threaded on to the pipe.

There are in general two methods of supplying the electric motor with current, by using a trolley pole and wire, suspended above the track as shown in one of the illustrations, or again by using the well known third rail system. The trolley wire, if used, may comprise a No. 6 or No. 8 B. & S. gauge copper wire, or else a piece of telegraph wire, sweated into slotted brass supports, which are secured to the ends of pipe arms fastened on light poles along the track. It is usually more or less difficult for the amateur railroad builder to construct a circular or oval track, and where sufficient space is available it is strongly suggested that at first a simple straight track be laid. The car or locomotive can then be run in either direction, simply by reversing the electric motor. A series D. C. motor, which is preferable for use in this case, owing to its high starting torque, is reversed by changing the terminals of either the field or the armature, but not both. A double-pole, double-throw knife switch will enable the electrical bug to easily rig up this reversing scheme. If a single-phase self-starting motor is used, having a special starting winding on it, its direction of rotation is changed,

simply by reversing the terminals coming from the starting winding at the connection block on the motor.

With regard to the driving arrangement between the motor and main axle, this, as aforementioned, may be accomplished with round or flat pulleys and belts, a rope drive with grooved pulleys having been used in some cases, taking care to make a tight, smoothly-spliced joint so that the rope will drive evenly; or a very good drive can be constructed from a bicycle chain, or better still, a motorcycle chain, with large and small sprockets, the smaller sprocket wheel being mounted on the jack shaft, as shown in the detail drawing of this feature. The driving connection between the motor and the jack shaft may be accomplished in one of several ways, using either two iron spur gears or else a chain and sprocket arrangement; if sprockets are used with a chain, the ratio of the teeth on them should be the same as the ratio between the two gears specified in the drawing herewith—i. e., 6 to 1.

For short railways, situated close to the house or other building from which the electric current supply is to be obtained, No. 14 or No. 12 B. & S. gauge insulated wire can be used. Where the railway is quite long, or situated a little distance from the house, heavier wires will have to be employed. By consulting Cushing's electric wiring manual, you will find directly from tables therein the size of wire necessary for carrying any current with a given voltage drop, or your local electrician will be glad to help you out in determining the proper size of wire to use, etc.

One of the accompanying diagrams shows how the trolley wire and track return circuit are connected up with the electric light circuit, and another diagram is given of the third rail connections when this method is to be used. The third rail, comprising a strip of band iron about 1 inch by $\frac{1}{8}$ inch, for example, has to be carefully insulated, either by using regular third rail insulators, or else by screwing the band iron to fibre or other good insulating blocks attached to suitable iron or wooden supports as shown in the figure. With the third rail system a fairly flexible, spring actuated contact shoe is necessary, and this is mounted on the side of the car if the rail is supported at the side of the track as here shown, or else the shoe is mounted under the car if the third rail is placed between the two outer running rails, as is sometimes done. The latter is not very advisable, as a person is too liable to receive a severe shock when he happens to step on an outside rail and the third rail unwittingly. It is best to place a light wooden strip at the

side and on the top of the third rail the same as the railroads do, for even when this is placed at the side of the main track, someone is liable to get a shock by stepping on both the common rails and third rail at the same time.

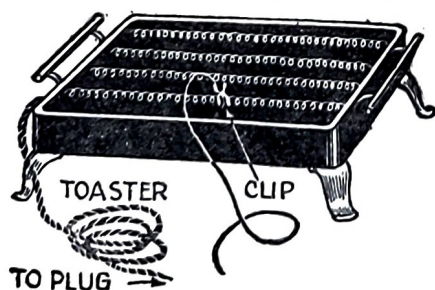
Where the trolley wire system is used, it will be found necessary to place this wire reasonably high, at least eight or ten feet, and as this wire is bare, the kiddies, and especially the grown-ups, should be thoroughly warned not to touch the trolley wire at any time while the railroad power is switched on, or they will get a shock simply by standing on the ground and touching the trolley wire. Standing on the ground and touching the iron rails will not cause any shock however.

One point to be watched in arranging the wiring on the car or locomotive is to see that a first-class connection to the wheels is provided from the motor or switch and rheostat. No. 14 or No. 12 insulated wire should be used in connecting up the motor and trolley pole, etc., and a spring brass or other satisfactory contact brush should be arranged to bear against the main axle. If wooden wheels are used, then the iron rims of the two wheels, which are rigidly secured to the driving axle, should be electrically connected with the axle by a piece of No. 12 wire, so that the current has a first-class path from the third rail or trolley pole, down thru the motor, to the rails.

For the D. C. series motor, a rheostat may be used, and if the proper size of iron or German silver wire is used in building the rheostat, so as to stand the current without getting too hot, several different speeds may be obtained. If the rheostat is used simply for starting up however, the lever simply to be moved over the contact points progressively to accelerate the motor gradually, then smaller resistance wire may be used. No. 16 to No. 18 iron or German silver wire will usually be found suitable, where the rheostat is to be left on different points for various speeds.

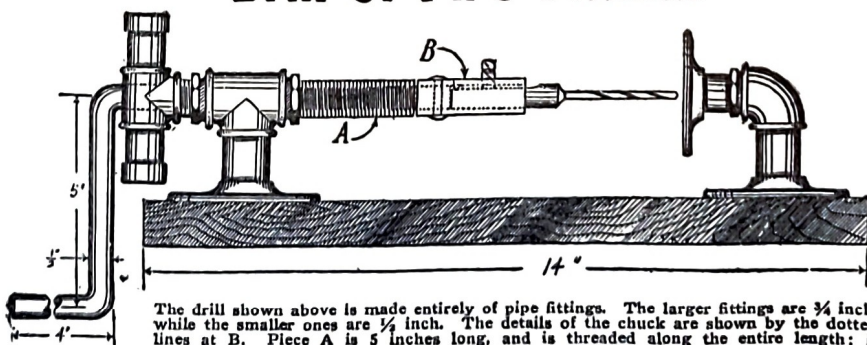
The electric headlight may be a home-made arrangement made from tin or sheet iron, or again, it may very well be a small auto headlight. The headlight may have a low candle-power 110-volt lamp placed in it, and be supplied with current from the 110-volt service, or it may be a battery lamp lit from a few dry cells or from a storage battery. An oil or acetylene bicycle headlight may also be used. For the locomotive a compressed air whistle may be easily fitted up with an air pump and small tank in which to pump air, the whistle being blown by pulling a rope fastened to a valve in the air line supplying the whistle. An electric horn such as used on automobiles may be utilized instead if desired.

Variable Resistor

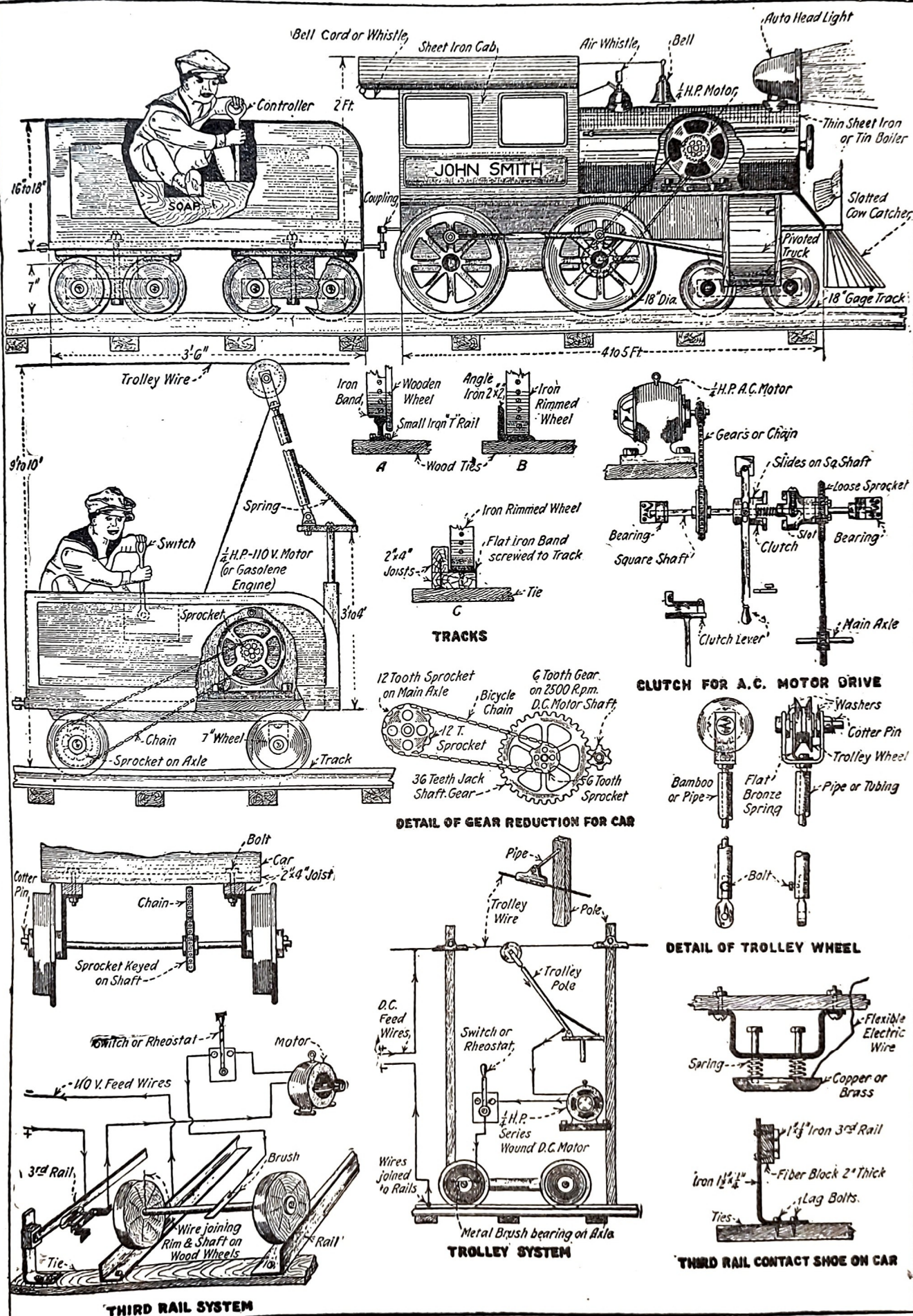


The heating element of an electric stove or toaster is often used as a resistance and it can be made variable if a clip is employed as shown.
—Hugo E. Anderson, Rep. No. 10,142.

Drill of Pipe Fittings



The drill shown above is made entirely of pipe fittings. The larger fittings are $\frac{1}{4}$ inch, while the smaller ones are $\frac{1}{2}$ inch. The details of the chuck are shown by the dotted lines at B. Piece A is 5 inches long, and is threaded along the entire length; it represents the feed screw.
—Harold Jackson, Reporter No. 2903.



Home-Made Electric Railway for the Kiddies—Fun for Builder and Rider Alike.

Small House Refrigerating Machine

By JOHN GORRELL

INTRODUCTION

BEFORE anyone can talk intelligently on the subject of refrigeration he must understand the principle on which the system works. In order that the reader may have an understanding suitable for the discussion and building of the machine, he should carefully examine the diagram below.

We shall assume that the valves F, B, and C are closed and D and A are wide open while the expansion valve is just barely opened. Furthermore that the condenser contains about ten to fifteen pounds of Sulfur dioxide (SO_2) in a liquid state under forty pounds pressure to the square inch. The pressure forces the liquid thru the small opening in the needle valve (also termed the expansion valve) into the cooling coils which are in the ice chamber. When the liquid is in the cooling coils, due to the lower pressure, it (the liquid) turns to a cold gas, which in turn robs the surrounding food-stuffs and air of their heat. When the gas

Under each type there are several models. The type as it is shown in the cut is made of one-quarter or three-eighths inch copper tubing. The minimum length is fifty feet while the greater the length (up to one hundred feet) the less time will be required for the gas to cool, as the surface area is larger. Seventy-five feet are enough for the average ice box.

A tank of any kind is made in which the coil is entirely submerged in water which is continually changing. This is brought about by having a pipe from the water mains, lead through a valve, to the bottom of the tank. With a drain pipe at the top, the water should not remain in the tank, when warmer than eighty degrees F. The amount of water needed will depend on how often the box is opened, the temperature of the room, and the weather.

If so desired, the coil need not necessarily be in the water, as it will operate if exposed to the air, though not so well. If this is done, it would be well to place a fan on the motor

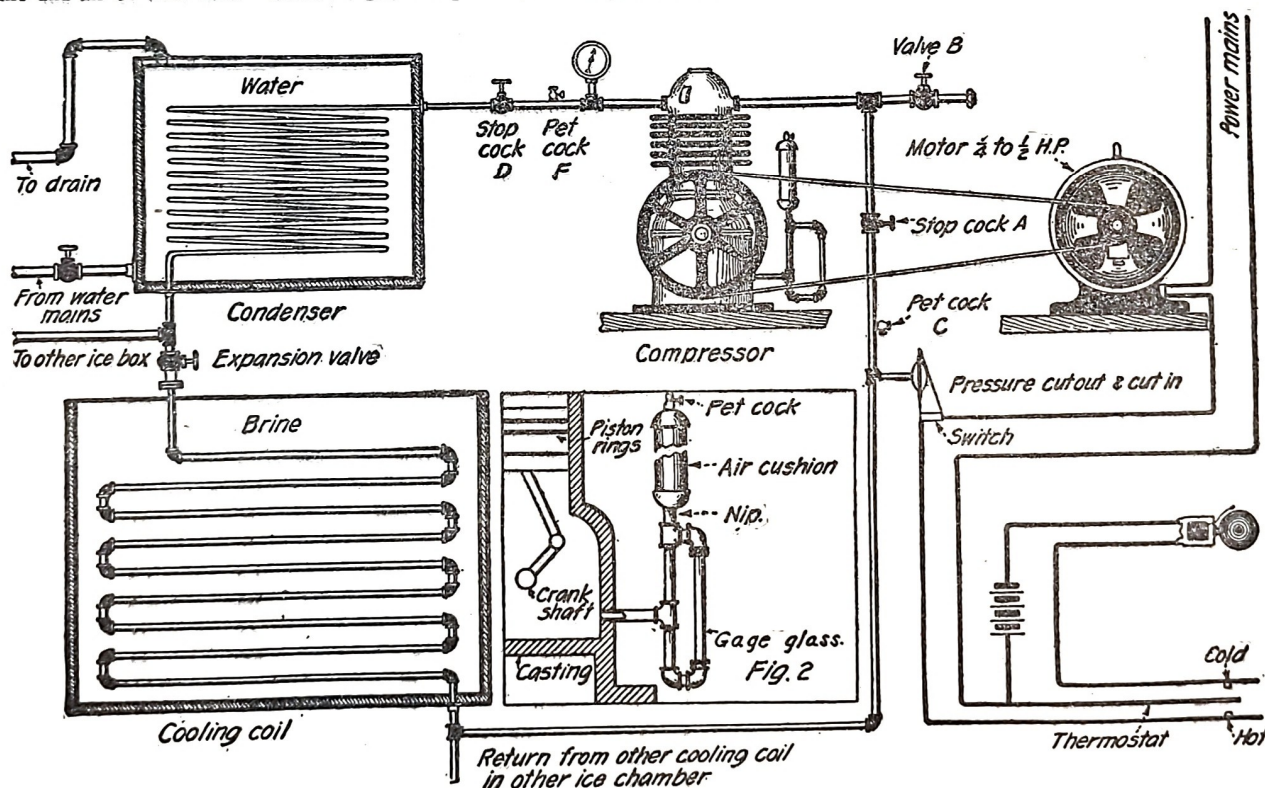
pressor may be placed above or below or to one side of the cooling coils, as pressure will force the liquid to the needle valve.

EXPANSION VALVE

The expansion valve, which marks the starting place at which refrigeration takes place, is a needle valve placed just outside the ice chamber or better, within it. Do not at any time tighten this valve more than necessary, as the seat is easily ruined.

COOLING COILS

There are two distinct types of refrigeration (cooling) coils, first there are the ones submerged in brine and those that are not. If the coil is to be placed in brine (concentrated solution) care must be taken to see that the tank is made of a material (metal) not affected by brine. An old copper wash boiler, reconstructed, is very satisfactory. This type is better because the temperature is more even.



How often have you wished that you could discharge the iceman and make your own ice with a little machine stored away in the corner of the kitchen or cellar? In the present article Mr. Gorrell tells us how he built his own machine for manufacturing ice. All the parts used are standard ones and can be purchased on the open market, including the sulfur dioxide, which is the refrigerant employed in this machine.

has absorbed enough heat, it is compressed in the condenser under a pressure and is allowed to lose the heat obtained in the ice box and that gained thru compression. When the hot gas has cooled sufficiently it returns to its former liquid state, only to go thru the same cycle an indefinite number of times with little or no loss.

CONDENSERS

There are two types of condensers used, namely the air and water cooled types. The former is less expensive to use and construct but is not as efficient as the latter type, which uses from one to ten gallons of water per hour.

or idler shaft. The air currents thus set up will greatly aid the cooling of the condenser coils.

An ideal and cheap condenser may be readily afforded by the use of a small hot-water or steam radiator, such as is used in heating systems. This radiator may be as large as convenient, altho one of six to eight sections (or coils) eighteen to twenty-four inches high and from six to twelve inches wide, will be large enough for most cases.

Any type of condenser must be placed, so that the liquid will all drain to the inlet pipe. If the radiator is used it is well to place it on an angle of twenty to thirty degrees. Any type of condenser and com-

COMPRESSOR

This is the most expensive item in work and money, as it is impossible (so far as I have been able to learn) to purchase an absolutely gas-tight machine of the small size. The next best thing to do is to purchase a compressor nearest to our needs.

When the machine comes from the factory it may require considerable machine work.

It will be seen by examination that the gas has several avenues of escape. This is not as bad as it may sound, since but one requires any great amount of work. Some six avenues will be enumerated with the methods of stopping them: No. 1. The

air compressor has a hand release valve which is placed in the head. This cup which contains the release valve is welded shut after the lever has been removed. (Care should be taken so as to allow sufficient room for valve stem. If the cup is filled with metal it will hold the exhaust valve open). The cup is screwed down and a good gasket made of drawing paper, well shellacked, put in.

The gas may leak out on the drive wheel side of the compressor past the shaft and out of the drain, which carries the excess oil to the crank case. Both of these are stopped by cutting off about one quarter of an inch of the shaft and milling the drain port to the same plane as the rest of the casting.

A sheet steel cap is made which is placed on the opening and when screwed tightly on the gasket will successfully prevent the gas from escaping at these openings.

No. 4. The vent under the flywheel side of the crank case must be milled to a plane, and covered by screwing a sheet iron plate over it.

No. 5. The gas will leak past the bearing on the driven end of the crank shaft. This is overcome by removing the old bearing

and boring the opening larger. A new bushing, of the best obtainable bronze, is then made, about an inch larger than the old one. An inside thread is cut in the projecting end and another piece of bronze is turned up and drilled, in order to make an inside stuffing box. This box should contain ordinary white cotton string saturated with oil and powdered graphite.

It is desirable to put a spring in the stuffing box so as to make it self-tightening.

No. 6. A method of closing the opening in the crank case, which contains the oil gauge, is to be worked out more or less by the builder.

The object is to close the opening so the gas cannot escape, but not so as to hinder the passage of oil and the reading of the oil gauge (which must be placed in the system) and to make an air cushion.

By looking at figure 3, the reader may see a projection of the part of the compressor concerned.

A small piece of pipe is run out of the opening down and out of the tee. The gauge glass and by-pass are placed as shown. (Great care should be taken to see that all joints are air-tight.)

The air cushion should be made of 14 inches of $2\frac{1}{2}$ " pipe or anything with equal or greater volume. This pipe is capped at both ends. A pet-cock is placed in the top for oiling.

When the machine has been tested for leaks and found intact, the pet-cock should be opened and filled with oil (while the machine is at rest). Close the pet-cock and the machine is ready for use. (Never under any circumstances permit the oil level to go below two and one-half inches from the floor base of compressor). Always take reading when the machine is not running.

The idle pulley is not used and will have to be removed.

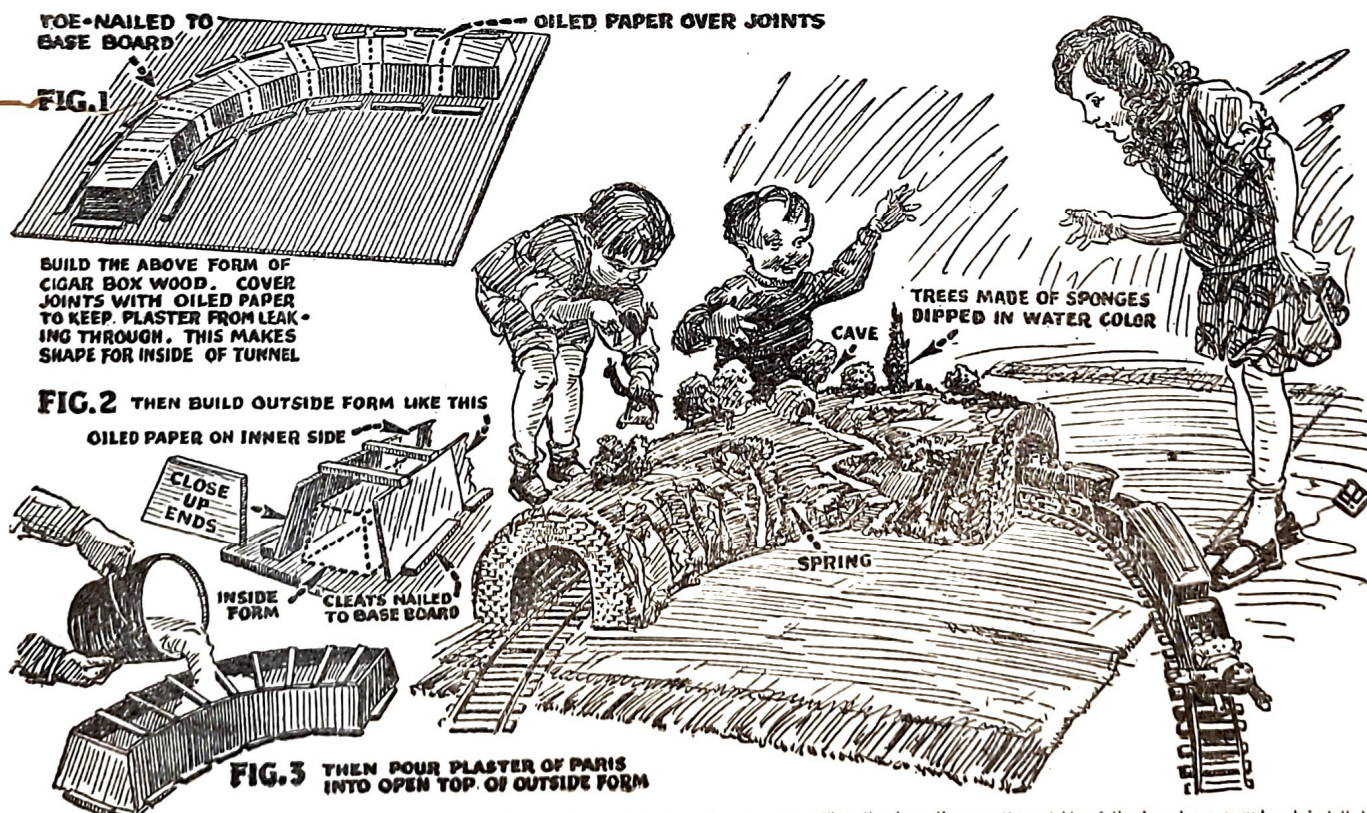
MOTOR

While a one-quarter horse-power continuous service motor will do the work, the increased original and running cost, of a one-third or one-half horse-power motor is well worth the difference, as the one-fourth horse-power is very slow and noisy in starting.

A motor running about one thousand two hundred and fifty revolutions per minute is the best.

Miniature Railway Tunnel

Plaster of Paris and Cigar Boxes Are Materials Used



The construction of the decorative tunnel for miniature railroads, illustrated above, is comparatively simple, and may be made by anyone at a small cost. The interior is first shown in Fig. 1, with cigar boxes. Later the outside form is constructed, as shown at Fig. 2, after which the form is filled with plaster of Paris. About twenty pounds will

be necessary. Then the decorations on the outside of the tunnel are carved and installed with the aid of a sharp knife, some sponges and water color. The inside of the tunnel should be wide enough to give half an inch clearance on both sides of the train, as it passes through.

—W. W. Douglas.

Build Your Own Reflecting Telescope

AT A COST OF \$26.30

By C. E. BARNES

Member American Astronomical Society, American Association of Variable Star Observers, Etc.

PART I—GRINDING AND POLISHING REFLECTORS

RECENTLY a gentleman of my acquaintance surprised me with the range and accuracy of his astronomical knowledge. A little later he further surprised me, on looking at the heavens through my telescope, by remarking, "This is the first time I have ever seen the stars through anything larger than a field-glass. Since I was nine years old I have been interested in astronomy—read everything I could lay my hands on relative to the subject—but, although I have been successful financially, I have never felt that I could afford a telescope of a sufficient aperture to satisfy my longings. I have found that such an instrument as I would want, costs in the neighborhood of a thousand dollars; and although I have seldom seen the time in recent years when I could not raise that amount for any purpose I saw fit, to expend so much on an intellectual hobby has never seemed quite expedient. Hence my resort to books, photographs of celestial wonders, an occasional illustrated lecture, and a field-glass. Perhaps some day—" he faltered, regretfully.

"Why not build your own?" I interposed. "This reflector through which you have seen the marvels of the moon in first quarter, the belts and moons of Jupiter, the crescent

of Venus, the rings of Saturn, the snow-caps of Mars, not to mention some of the stellar wonders—clusters, nebulae and multiples—was built by myself through sheer exercise of ordinary skill and ingenuity, a resolve to get up an hour earlier each morning for a few weeks, and at a total expenditure of twenty-six dollars and thirty cents.

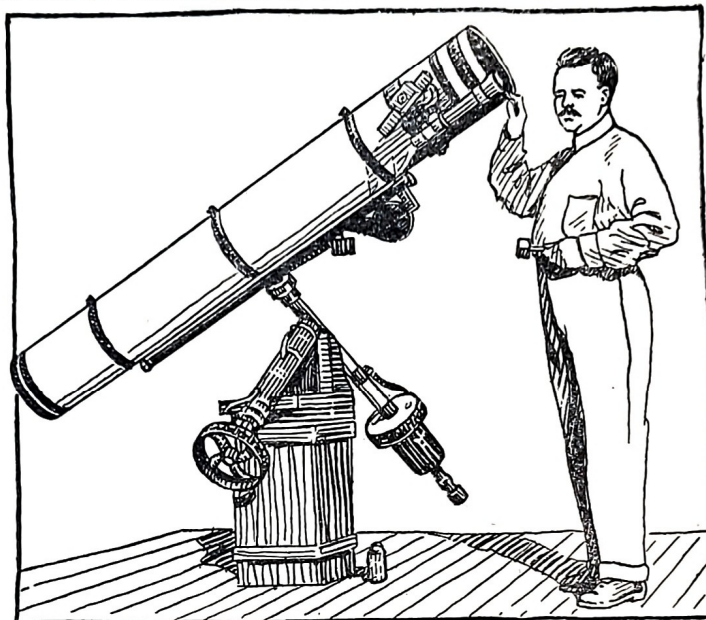
the grinding and polishing of the speculum before undertaking the mounting. As to the first of these, a six-inch mirror requires as much work to construct as an eight or ten-inch one, and gives far less satisfaction. It must be remembered too that magnifying power increases with four-fold ratio when the diameter is only doubled;

What I have done you yourself or anybody else may do quite as well or perhaps even better. Why don't you try it?"

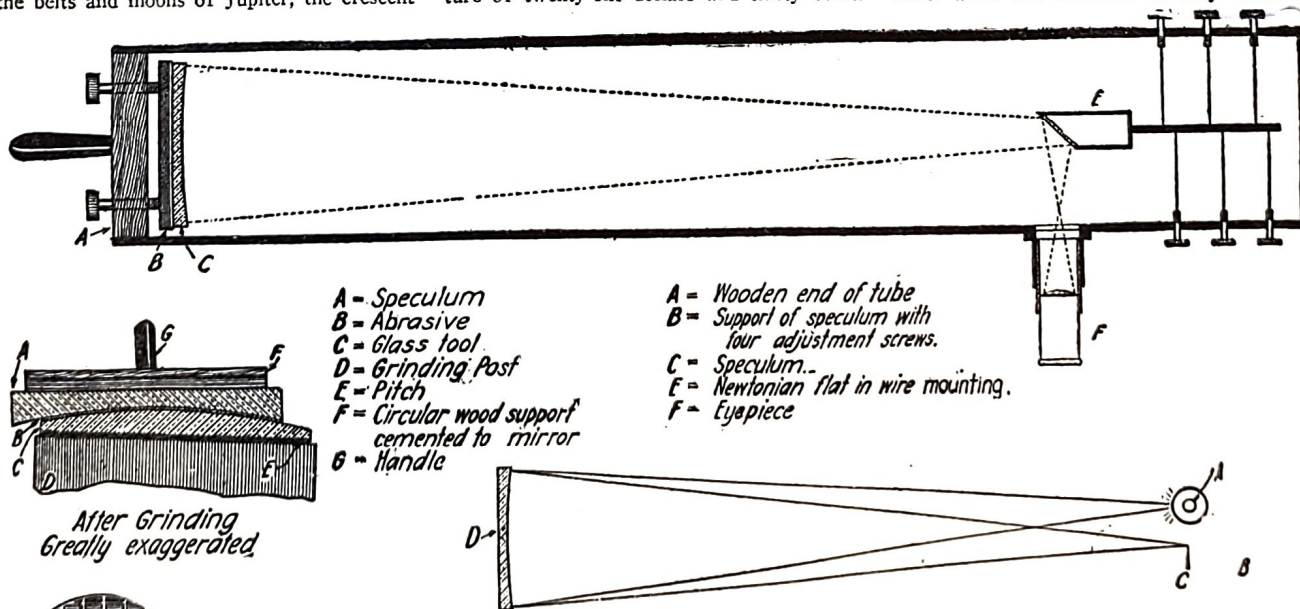
"I certainly shall—beginning at once," said my friend with new enthusiasm. "Tell me all about it."

So herein I have set down the main points of reflector-building, which, if followed carefully, should lead to success. I have started novices, young and old, in the delightful pursuit of telescope-making, and from what I hear of the work of some of my recruits, their mentor himself must look to his laurels. For, as in every other kind of delicate work into which a man throws himself heart and soul, each individual craftsman sees opportunities for improvement in designs and methods, exercising his particular ingenuity; and herein lies the charm of the work.

Two things I have always advised from the outset—not to begin too modestly as to size of instrument, and not to wait till after completion of



Photograph of Ten-Inch Home-Made Reflecting Telescope, and the Man Who Built It, Mr. C. E. Barnes, Describes Here in Exact Detail Just How to Build One Yourself At a Cost of Approximately \$26.30. The Detail of the Eye-Piece and Base Support are Clearly Shown in This Photo.



- A - Speculum
- B - Abrasive
- C - Glass tool
- D - Grinding Post
- E - Pitch
- F - Circular wood support cemented to mirror
- G - Handle

- A - Wooden end of tube
- B - Support of speculum with four adjustment screws.
- C - Speculum.
- E - Newtonian flat in wire mounting.
- F - Eyepiece

After Grinding Greatly exaggerated



Wax-covered polishing tool showing method of laying of squares. In parabolizing these squares are pared down to half size except in centre, in order to hollow out centre of mirror, as explained in text.

- A - Pin-hole star box with electric bulb suspended opposite hole to represent a star.
- B - The operator's eye brought close to razorblade edge.
- C - Knife-edge.

FOUCAULT KNIFE TEST TO DETERMINE PARABOLOID FIGURE AT CENTRE OF CURVATURE

Several Details of the Ten-Inch Astronomical Reflecting Telescope Are Given in the Drawings Above. The Author Explains in Minute Detail All of the Various Stages To Be Followed and Specifies the Materials Necessary in Grinding and Polishing a Ten-Inch Reflector.

that is, a ten-inch gives not twice but four times the power of a five-inch, and other sizes in due proportion. I have a nine-inch, of sixty-eight inches focal length, and the difference between them is to the very marked advantage of the larger.

The construction of the mounting we will take up in a later section of this paper; but as a preliminary injunction I would recommend beginning the construction of the mounting simultaneously with the work on the mirror. The reason is a very human one—for the process of grinding and polishing is so engrossing, with enthusiasm growing apace with each stage of development, that the desire to put the finished product to test on the heavens is a very natural one; and if one must wait for the mounting after having struggled so long, although interestedly, with the speculum, and then be compelled to put off the finishing processes till after the mounting is built, one's enthusiasm suffers something of a check. It is one of the greatest delights in telescope building to be able to slip the finished product right into the tube under the stars and give it its first real try-out, and for that reason I always counsel novices to do the work simultaneously. Besides, the construction of the mounting will be found to be a pleasant relief from the rather monotonous labor over the grinding-tool.

With the differences between refractors, and reflectors in general and the laws and rules which govern their optical principles, we need not deal in this paper, since any good encyclopedia will inform the novice fully and accurately, on this point and as to the different forms of the reflector. We will concern ourselves with only the practical side of constructing a Newtonian, so-called, since Sir Isaac Newton constructed the first one with his own hand—a tiny thing of only two inches aperture—exhibiting it for the first time before the Royal Society of England. Yet from this tiny model able men have developed the reflector till now (culminating in the great hundred-inch mirror at Mt. Wilson), the instrument of the future is undoubtedly the reflector; for whereas, owing to the enormous cost and difficulties of construction, the limit of refractors has about been reached, no one can predict what great reflectors will yet be mounted and put to the highest uses, chiefly in the domain of celestial photography. A preliminary reading-up on this subject, using such authorities as almost any public library affords is recommended.

Having decided upon the size of your instrument, the first step is to procure your glass for the speculum. As only the surface-reflection is used, so-called optical glass of lens fineness is not necessary. This is fortunate, else the initial outlay might run into some hundreds of dollars instead of only five or six dollars for a selected piece of plate glass cut, let us say, ten inches in diameter, ground at the edges, free from scratches and surface flaws, and as thick as possibly can be obtained of any commercial plate glass dealer. This may be two inches, but more likely one and three-quarters, or at least one and one-half inches thick; but anything thinner for a ten-inch is not recommended. Secure at the same time another disc of glass of the same size and grade, though it need not be more than three-fourths of an inch thick. This will serve as a "tool" upon which the grinding is done.

As you value peace in the family, do not attempt speculum-grinding within the four walls of your neatly-groomed home; for with the drippings of carborundum, emery and jeweler's rouge, the immediate region of the grinding-post will be pretty well messed up before your pleasant labor is done, and your clothes and person generally (in spite of an enveloping apron), will resemble a potter's at the close of a busy day.

Choose rather a shed or some sort of an outhouse before an open door affording light and air as well as a pleasant prospect, perhaps, for the work grows tedious at best after the first few hours. A twenty-gallon iron Standard Oil drum, filled with water to give it weight, resting on a stout box filled with crushed stone, itself standing on the solid earth through a hole cut in my observatory floor has afforded me a solid foundation for the tool which is securely cemented on the drum-top, perfectly level, and of a convenient height for steady work. The more light and airy the surroundings the more pleasurable the work becomes.

A template for testing the curvature of the mirror is easily made and is quite indispensable. Having decided on a ten-inch speculum, let us say, you will next determine the degree of curvature—in other words, the focal length. The degree of curvature may be anywhere from six-to-one to twelve-to-one, a reasonable average being about nine-to-one. This gives you a focal length of ninety inches, for a ten-inch mirror. Lay down a straight piece of batten twice the focal length, or one hundred and eighty inches, on some bare floor. Drive a nail in one end, securing it sufficiently to serve as a fulcrum, measuring the exact length on the rod and driving a sharp tool through the wood so that when it is moved from right to left the tool will scratch a curved line beneath. A flat piece of zinc may thus be marked so that with a pair of tinner's shears a satisfactory template can be made. As this metal gauge represents the approximate curvature of your mirror, as the grinding proceeds your progress can be noted by standing the convex edge of the template across the mirror at its center. When the grinding has reached a point where the template fits the concavity of the glass, the fine grinding and polishing may begin.

Another way of testing your progress is to cover the speculum with warm water (never cold, or you will crack your mirror), and hold the glass in the sunlight where it will throw an image on the wall at about the focal distance—ninety inches. At first this image will be almost as large as the mirror; but as the grinding proceeds, the image on the bare wall or white sheet of paper, will be seen to grow small, till at last it will appear as a burning bright spot about the size of a half-dollar, at which point grinding may cease.

As an abrasive I used various grades of emery on several mirrors, but for rough grinding carborundum is far superior, working much faster. Secure half a pound each of five or six grades from "40" to "200," and a pound of the finest emery-flour for the finish. Two hours' grinding with each of these grades, finishing with the emery, will bring the desired curvature to the glass; perhaps even less time than that; but if you get your full concavity within nine or ten hours (working from twenty minutes to an hour a day), you will do well. A teaspoonful of the abrasive mixed to a thin paste with a little distilled water is sufficient for each grinding; and before resuming operations the day following, wash off the glass thoroughly. Especially as you proceed from one grade to another, wash off every grain of the preceding grade, else you will have pits and scratches which will be very troublesome to grind out.

Most amateurs find the grinding comparatively easy, but the polishing long and difficult. This is mainly because they have not carried fine grinding far enough.

A wonderful surface may be obtained by using the emery in various grades of suspension. Place the pound of emery in a fruit-jar and nearly fill with distilled water. Shake well and let it settle one minute. Pour off the water into a second jar and spoon out the emery down within a half-

inch of the bottom where the heaviest grains have settled. Shake this emery in the second jar of water and let stand for ten minutes. Pour water into jar 3, and spoon out the top half of the emery, proceeding as before, allowing the abrasive to settle for one hour. The final "washing" should be ten hours or more, this last grade being of course the very finest emery dust. By using the top layers of each grade, and washing between, giving each ten to fifteen minutes' grinding, the surface of the mirror will leave a texture that will make polishing comparatively easy.

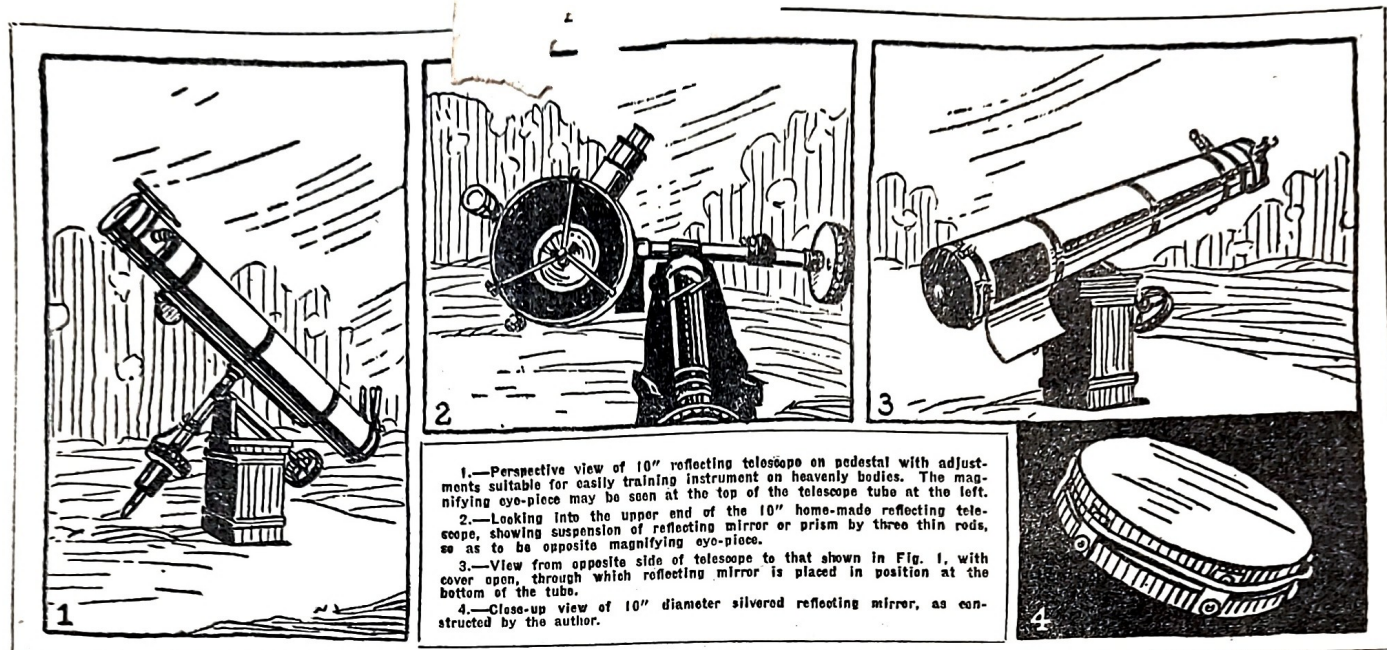
In grinding I use three circular strokes to one straight across; in polishing, the straight stroke is preferable. In making each turn in the circular stroke it will be noted that one-third of the mirror is off the edge of the tool all the time and the central portions always grinding—which accounts for the puzzling phenomenon of increasing concavity. I never use extra pressure than the weight of the glass. With every stroke I turn the speculum by the handle an inch or two, at the same time taking one step to the left around the post, making a complete circuit about every ten or twelve strokes. Thus the grinding proceeds evenly.

The method of polishing is exactly the same as the grinding except that the tool is now covered with a layer of black pitch; and instead of an abrasive, red oxide of iron, or jeweler's rouge, is employed as a polishing agent. I have had the best success with Snow's grafting wax (to be had of almost any dealer in horticultural supplies), being of just the right texture and free of any foreign matter, and neither too soft nor too hard. However, ordinary commercial pitch will do, melted and strained, with a little turpentine added to soften it, so that when cold it can be easily dented with the thumbnail. While warm, but not too hot, flow the pitch over the tool to the depth of a quarter inch; then having first wet the speculum with castile soap and water, press the mirror down on the wax, moving it around and around till a perfect impression is obtained. Before it is quite cold, lay a straight-edge across the tool and with a knife dipped in soapy water cut V-shaped grooves clean across the face of the tool about an inch apart, then another series crosswise so that your tool is now a series of inch-wide squares. Clean the tool with soap and water and let harden.

Place a pound of the rouge in a jar of distilled water, shake and let stand overnight. Pour off the water (leaving about an inch to cover), and spoon off only the top portions for polishing. Cover each square with this washed rouge, and proceed to polish with a straight stroke, twirling meanwhile and keeping in constant motion around the post. Within twenty minutes or so the center will be seen to brighten, and little by little the whole concave surface of the speculum will polish. As a finishing to this process—for you cannot have too brilliant a surface—I have used with success a coating of pure beeswax over each wax-square, the melted wax laid on very evenly with a single stroke of a fine surgical gauze brush. The best wax for this purpose is that used by bee-raisers for foundation-comb. It comes in sheets and is highly refined and dustless, and is cheap. Of one thing make certain: do your polishing with windows and doors closed, as one grain of sand or even dust blown on to your glass during the process will possibly ruin it and drive you back to grinding again.

You have now perhaps a speculum in perfect curvature, but this is not enough. It must still be parabolized—that is, made a little deeper in the center, so that the rays from all parts of the mirror will focus to a single point instead of distributing along the focal plane. In other words, the

(Continued on page 109)



1.—Perspective view of 10" reflecting telescope on pedestal with adjustments suitable for easily training instrument on heavenly bodies. The magnifying eyepiece may be seen at the top of the telescope tube at the left.
2.—Looking into the upper end of the 10" home-made reflecting telescope, showing suspension of reflecting mirror or prism by three thin rods, as seen from opposite side of telescope to that shown in Fig. 1, with cover open, through which reflecting mirror is placed in position at the bottom of the tube.
3.—View from opposite side of telescope to that shown in Fig. 1, with cover open, through which reflecting mirror is placed in position at the bottom of the tube.
4.—Close-up view of 10" diameter silvered reflecting mirror, as constructed by the author.

Build Your Own Reflecting Telescope

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Member American Astronomical Society, American Association of Variable Star Observers, Etc.

Part II.—SILVERING THE REFLECTOR

AN unsilvered mirror will give a very fair image of a bright object like the moon, but a properly silvered one will afford eighty or ninety per cent. of reflection—a colossal advantage. The silvering process then must be done thoroughly and with great care; and is one of the most beautiful experiments in telescope building. Nor is it at all difficult, as anyone who has had any experience in amateur darkroom work will appreciate. For, whereas no darkroom is necessary, the same rules with regard to exact measurements of chemicals, regulations of temperature and above all *cleanliness* obtain in perfect silvering as in perfect negative-making; and there should be neither haste nor guesswork. These chemicals will cost a couple of dollars; but there will be sufficient for half a dozen trials; so if at first you do not succeed in achieving a perfect film, wipe it off with dilute nitric acid and go at it again. If you follow directions you are sure to succeed, probably with your first attempt.

Clean four quart bottles thoroughly, and label: A, B, C, and D.

Solution A—Nitrate of Silver, 175 gr., Distilled water, 10 oz.

Solution B—Ammonium Nitrate, 262 gr., Distilled water, 10 oz.

Solution C—Granulated Sugar, one-half oz.; distilled water, 5 oz. Dissolve and add tartaric acid, 50 gr. Boil in glazed dish 10 min., then add pure grain alcohol 1 oz., and water to make 10 oz.

Solution D—Caustic potash (purified by alcohol), 1 oz., distilled water, 10 oz.

Lay speculum in large earthenware dish, face up. Cut a three-foot strip of stout wrapping paper, two or three inches wide, and run through a dish of melted paraffin. When cold, wrap tightly around edge of speculum and tie securely with cord. This will make a dish to receive the silvering solutions.

With a wad of surgical gauze dipped in pure nitric acid, go over every part of the

face of the speculum with great care four or five times. Rinse with distilled water and repeat. Ten or fifteen successive washings of the glass are none too many to insure a perfectly clean surface, for be warned of one thing: if there is a spot of finger grease or other foreign matter on the mirror as large as a pin-head, it will not receive the silver. After the final rinsing, cover glass with distilled water and let stand in same temperature as the chemicals for several hours. At temperature 80° F., the silver deposits best. If warmer, it deposits too fast and is too soft to polish well; if cold, it deposits too slowly.

Place two clean beakers side by side. In the first mix one ounce each of Solutions A and B. In the second beaker, mix likewise one ounce each of Solutions C and D. You are now ready to silver.

Pour off the distilled water which has been standing on the speculum, replace mirror in dish, then quickly empty the contents of one beaker into another. The solution will turn straw-color, then deepen to brown and thence to inky blackness. At this instant flow over the speculum and rock as when developing a photographic plate. Within a few seconds the silver will be seen to film over the entire disk, and little black granules will form through the solution. At this point, before the solution gets muddy, as it soon will, rinse out the two beakers with distilled water, and mix Solutions A and B, and then C and D, then mix together as before. Quickly pour off the muddied solution from the mirror and pour on the new, rocking again. This will double the deposit of silver. Do this still a third time, and even a fourth, if, on holding the mirror up to the window, the film of silver appears to be too thin. It should not be opaque, but objects dimly outlined through it. Rinse mirror with half a dozen or more changes of distilled water to eliminate all trace of solution, flow over an ounce or two of denatured alcohol and set up in a sunny window to dry. If your glass was clean, the temperatures of chemicals and speculum all equal, and your chemicals guar-

anteed, C. P., you probably have a mirror that is perfect enough to adjust in your telescope without further polishing, for all ordinary visual work. Still, you will want the brightest surface obtainable—one approaching as nearly 100 per cent. reflection as possible—so, after a day or so drying and hardening in the sun, lay the speculum on the shelf of a stove to warm and prepare for quite a tedious but wholly worth-while job.

From the well-washed jeweler's rouge, which you used in the polishing process, spoon out about as much as would cover a silver quarter. Place in a dish on a stove till bone-dry. Wrap in a piece of new chamois skin and pound to finest powder. The chamois will take up almost enough of the rouge to polish, but a little more may be supplied from time to time. Wrap the chamois around a wad of cotton, then warm over the stove. The mirror should be quite warm now; and beginning at the center, with a light circular motion polish evenly and with extreme care. You will soon be gratified by the result; and after an hour's work your speculum will resemble a polished block of the finest ebony.

You will be so pleased with your accomplishment now that you will be doubly glad that you started building your mounting about the time of undertaking the grinding, for you can hardly wait till nightfall to give your handiwork the supreme test on the moon, double stars, clusters and nebulae as well as the planets. Even with low-power eyepieces you will be staggered with the light-gathering power of your mirror. Theoretically it will give you nearly a thousand diameters with a high-power ocular and perfect seeing; but you will rarely require more than two hundred; and for ordinary observations a power of fifty with a ten-inch is sufficient. It will show the crescent phases of Mercury and Venus; the moons and markings of Jupiter and Mars; the wonders of the trapezium in Orion; multiple star systems and clusters in thousands of celestial marvels, as well as the endless catalog of lunar phenomena, the disk of the moon filling the entire field.

In constructing the mounting, three things are essential: rigidity, ease and smoothness of the working parts, and balance. It may be set up in any open space, or on a flat house-top—anywhere commanding a comparatively unobstructed view of the heavens. A dome or even a housing is not entirely essential since by fitting a tight, felt-lined cap over the speculum (reached through a door in the side of the telescope tube), and enclosing the open end of the barrel with a canvas bag, and tying a piece of tarpaulin over the entire working parts, it will stand the year-round weather. A well-silvered mirror is good for a year or more, though it is a simple matter (and an always pleasant experiment) to take it out of the barrel and resilver it if it shows deterioration; and the chemicals work even better with months of standing in a dark place in rubber-stoppered bottles.

Choose then a spot that has at least a free north-and-south view, setting solidly in the ground a four-by-four post two feet below and two feet above your platform. Around this set a box made of twelve-inch boards, placed squarely to the points of the compass, fill the spaces between post and interior sides of the box with crushed stone and concrete for solidity, placing thereon a heavy hardwood platform, squared and leveled.

The ordinary alt-azimuth mounting is easiest of construction, but the equatorial gives the greater satisfaction. Ordinary inch and a half and two-inch iron piping can be used to advantage so long as the joints are machine-threaded for accuracy, not hand-threaded. The bearings on both polar and declination axes may be ordinary tight-fitting steel collars, but any second-hand automobile shop can supply ball-bearing supports from discarded motor cars for a dollar or two each, and these will give your telescope perfect ease and smoothness of motion in following a star or planet. Right ascension and declination circles can also be constructed of discarded belt-wheels, painted black and marked off in white, the former with Hours and Minutes, 1 to XXIV, and the latter Degrees and Minutes, 1° to 180°, running each way, the reading depending upon which side of the pier your telescope is swung. Old clock-hands affixed to the iron tubing will do for indicators. When the declination axis is perfectly horizontal, the R. A. circle should be set at 0 hrs., min., and secs. When the telescope points directly to the North Star (Polaris), the declination circle should be set at 90°.

A heavy wedge of wood supports your telescope, and this should be sawed to an angle equal to the latitude of the place, so that when the polar axis is set upon it,

on looking through it, Polaris should be accurately centered. Get your north-and-south line as accurately as possible, although the determination of the true meridian is a task which tries the souls of some of the best astronomers. A fair approximation only is essential.

The metal telescope tube is probably one of the things that had best be left to the trained metal-worker; and for a thorough piece of work should not cost more than seven or eight dollars. It should be eleven inches in diameter throughout—an inch larger than the mirror; and four inches longer than your focal length—ninety-four inches to end of sleeve in case you have ground your ten-inch speculum at the ratio nine to one. A door should be cut in the lower end, properly placed and large enough to pass the mirror in and out without ever touching its face; and the upper end should be fitted with a revolving sleeve extending eight inches or more over the main barrel. This sleeve carries your finder, diagonal and eyepiece, and can be fitted with rings to run smoothly. In smaller reflectors the entire barrel revolves in its bed; but with a ten-inch the revolving sleeve is far better, as the finder and ocular can be instantly adjusted for seeing, in whatsoever position the telescope stands. In the side of the sleeve a hole is cut in which is fitted a block to hold the ocular-tube which should slide in and out easily to get a proper focus. With a steel tape and the sun's image thrown upon a piece of cardboard, determine as accurately as possible the focal length of your mirror, then cut down or lengthen your telescope tube to correspond. Remember, this focal length represents the distance between mirror and eyepiece, not alone from mirror to diagonal.

The diagonal, or Newtonian flat, as it is called, is merely an oval piece of glass, silvered on the face like the speculum, and set at right angles in the focal plane opposite the eyepiece. The diagonal may be cut out of any piece of plate glass, free from scratches, ground oval and large enough to receive the reflection—say, one and one-half by two and one-half inches, and silvered in a small agateware dish as carefully and polished as brilliantly as the speculum itself. This may be clamped (not merely cemented), to a block of wood cut accurately to forty-five degrees and supported in the focal plane opposite the eyepiece by a series of wires running crosswise through the barrel. I have found a right-angled prism of optical glass preferable to the Newtonian flat, particularly for celestial photography as it reflects 100 per cent., but they are usually made to order and cost twelve dollars. All the large reflectors use plane mirrors for diagonals; and if the silvering and

polishing is well done, the loss of light by reflection is negligible for visual work.

It is scarcely necessary to state that your instrument will need counterweighting to a point where all movable parts work smoothly. I have found old stereotype metal, to be purchased for five or six cents a pound at almost any print-shop, the best for counterweights as it can be melted and poured into a small space, and is very compact and heavy.

As for eyepieces, I have a complete battery of them; but I must confess that an ocular of my own construction, made of lenses that once did service, I fancy, in some little old tintype gallery, ground by a famous English lens-maker of long ago, is my favorite for observational work. I think I paid a dollar for six of these lenses in a second-hand shop; and though the rest of my oculars cost from four to thirty-eight dollars each, I get the best service out of these castaways which give me from about sixty to one hundred and ten diameters. You never know when some battered and antiquated cell in a cobwebbed window contains a mighty fine lens that is just what is needed for an eyepiece; and even if the amateur does secure his oculars from some reputable dealer and pay the price, he will nevertheless continue treasure-hunting along these lines.

And what is true of eyepieces is also true of finders; for one may often pick up a small but powerful field-glass, giving a clear wide field, in which he can insert cross-wires, that may be mounted on his reflector and serve his purpose as well as one of the professional kind that costs twenty to forty dollars. A finder is a great help, and in some classes of work quite indispensable.

Let me say in conclusion that one of the best travelers I ever met was a man who was never in a hurry to get to his journey's end, but took all the pleasure and profit out of the day's progress that he possibly could. In telescope-building you can learn as much or as little about optics, chemistry and mathematics as you personally can wish, for the field is immense and the rewards of success are very great. But if you make up your mind to get out of every day's progress its modicum of intellectual profit, making haste slowly, you will double your pleasure and be surer of ultimate triumph. As one of scores of my correspondents writes, "I took your advice not to spend five hundred or a thousand dollars for a telescope, but to build one myself, so I took my coat off and went at it, and today have an instrument that I am proud of, besides a knowledge of practical astronomy that I would never have acquired in any other way."

Build Your Own Reflecting Telescope

(Continued from page 107)

wax or pitch on your polishing tool must be pared down at the edges so that the center receives almost all of the wearing away of the glass, and the mirror thus receives an imperceptible dip. If you leave the central squares intact and widen the grooves toward the edges of the tool till the outer squares are about half their original size, then proceed with your polishing as before for about fifteen minutes, you will reach the approximate depth of parabolizing, the test of which is in your telescope on the moon or a star, or best of all the Foucault knife-test which is now to be explained so that anyone can accomplish it.

This requires no elaborate apparatus. Set up the mirror vertically against the wall of a darkened room. Opposite this place a

small table about on a level with it, and at a distance twice the focal length, as when making the template. On this table place a deep tin coffee-can in whose side, directly opposite the mirror, is punched a very fine hole with a needle. Suspend opposite this hole an electric bulb, flashlight or oil-lamp. This will serve as an artificial star. Now to the left of this point of light, and on a level with it, set up a safety-razor blade flatwise toward the mirror. Bring the eye close to the edge of the blade and move the lamp sideways till the artificial star is seen to illuminate the whole mirror. By moving the knife-edge slowly, the mirror will be seen to darken uniformly over its entire surface, if the parabolizing has been carried far enough. If there are unequal-

ities, the speculum must be returned to the polishing-tool whose pitch surface must be cut to smooth down these particular inequalities, and another test made. By careful practice and successive tests a perfect parabolic form may be reached, but care should be exercised not to over-parabolize as it means a return to grinding again. Likewise at this center of curvature if the image of the artificial star is viewed with a low-power ocular, it will be seen to be a ragged disc of light about the size of a dime; and if by crossing and recrossing the field with this disc of light it remains sharp and clear to the very edges, the mirror is testing well and can be placed in the telescope for tests on the moon and stars.

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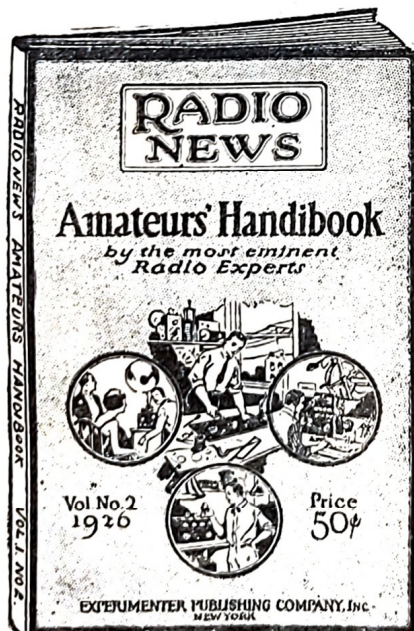
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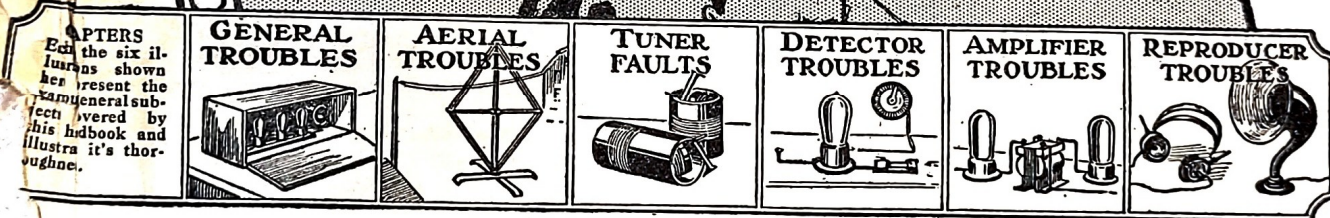
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